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THE RELATIONS OF WOMEN TO CRIME.

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I.

THE first traditional crime, the fratricide of Abel, was a natural outgrowth from the conditions of society, which, compared to the present relations of civilized men, existed germ-like around him. These conditions alone gave motive and direction to the deed. To all the after-centuries of human crime this primal offense has existed as a type. Both in cause and effect it is reduced to its simplest proportions. The criminal represents the retrograde tendency of society; the savagism which exists in every community. Order and progress are preserved by an irrepressible conflict waged on the border-land, as it were, of civilization. Many of these crimes grow out of the artificial wants of society. Others are but relative and belong to particular conditions, or orders of men, and at other times and places are without meaning and void of offense. Thus society is ever eager for the warfare, and, at the time it creates the crime, prepares the weapons for its punishment.

The propensity to crime is a fixed element in human nature. Quetelet, whom I have frequently referred to in the course of these papers, has with singular sagacity and perseverance reduced the social relations of man nearly to an exact science. The dark and tortuous by-ways in life, which so many seem perforce to follow, arrange themselves with the regularity of geometrical lines under the clear illumination of his analysis. Yet these are surface-lines only. There are profound depths of human misery and crime, over which a veil seems drawn by a merciful hand, and in which we have but a suspicion of the force of law. But, in these depths, in which the terminal fibres of human relations find soil and sustenance, can be found the origin of the ordinances under which these surface-lines are grouped. If this be so, it follows that crime must be studied as a natural phenom-

enon rather than as an accident. Those efforts which society has made to stamp out and confine this tendency to evil must, to an equal extent, spring from higher law; just as a breakwater is reared to protect an exposed harbor from the encroachments of storm and wave.

We have of late years come to look upon criminals as a special class of the community. We have come to complacently call them the "criminal class," just as we do the mercantile class or any other reputable order of men. This is so far true as to be capable of proof more by the exceptions than the rule. We have come to look upon crime as we do the typhus fever or the cholera, as prevailing mainly amid dirt and ignorance. I believe this to be true only so far as ignorance permits those good qualities in men to be undeveloped which require culture for their development; and the existence of such qualities has not as yet been demonstrated. It must be understood that while the word "ignorance" does not express a positive quantity, it yet expresses a positive quality which is true of the mass of people. This word with perfect fairness may be applied to the vast numbers which swell the aggregate of a census-table, without any qualification. I believe it can be shown that it is simply from excess in numbers that the ignorant classes furnish the recruits to the ranks of crime, and not from any tendency to crime dependent upon the negative quality of ignorance. A careful analysis of facts in this field induces Mr. Buckle to say that "the existence of crime, according to a fixed and uniform scheme, is a fact more clearly attested than any other in the moral history of man."[1] Another high authority may be quoted in evidence to prove that this scheme is exempt from those laws which govern intellectual development: "It is one of the plainest facts that neither the individuals nor the ages that have been most distinguished for intellectual achievements have been most distinguished for moral excellence, and that a high intellectual and material civilization has often coexisted with much depravity."[2]

All this seems to show us that there is a rhythm in human actions that forms a minor chord in the forever unwritten music which those who love Nature know as existing profoundly in all her works.

Since we are dealing with an element in human character which preserves a fixed value, it is evident that we may study the relation of any class in any community to these constantly-recurring phenomena, provided we can isolate this class from all others. In the study before us, this has already been done by the division of mankind into the sexes. I need draw no other line. Women stand out so clearly as a class, and, in relation to any series of acts which preserve a more or less constant periodicity, are so sharply defined from man, that they are easily contrasted with him in relation to any condition common to both.

[1] "History of Civilization in England," vol. i., pp. 22, 23.

[2] "History of European Morals from Augustus to Charlemagne," vol. i., p. 157.

I have already called attention to the fact that intellectual development obeys other laws than those which relate to crime. This requires to be brought out more clearly in relation to women. In this age women are receiving more chivalric attention, more material respect, than in any other known to history. In this century they are accorded the full right, and are given the aid of some of the best intellects among the other sex, to adjust those wrongs under which they have labored for ages. They are identified with every scheme of love and purity which demands good motives and a sympathy that never slumbers. It is for this reason, then, that, when we associate women with the idea of crime, it is difficult to believe that they are not influenced by other laws than those which affect men. There is nothing in a brawny hand and coarse muscle which tends to evil. The hand which executes may be white and begemmed. The mind which plans may be cultivated and refined.

In the study before us, we shall be obliged to resort to other facts than those simply contained in tabulated statements of crime. Statistics has done much in social study, and in this instance it has pointed out the existence of law in human action in the aggregate; but it has gone no deeper. We can establish by its means a probable difference in the degree to which the sexes are affected by crime; we can so group these numerical statements that they will be a mutual check upon each other, but if we are to learn any thing of the under stratum of human life, of its curves and faults, of which we see only here and there an upheaval upon the surface of society, we must study sexual and general character, we must observe the mutual relation and dependence of the sexes and classes upon each other, and give due credit to the cerebral and physical differences which go to make up the sum of sex—all of which are beyond the province of figures to express. In the course of these papers, therefore, I shall resort to statistics only to the extent I have mentioned. The popular character which I have endeavored to give them also forbids the resort to statistical detail, except to the extent which is inseparable from the nature of the study.

As in hygiene so in crime, there is not one law for woman and another for man. The emotions which impel to crime are few, and to the operation of which the sexes are both exposed. But, it does not follow that these causes react in the production of crime to an equal degree. The propensity to crime, as defined by its actual commission, is four times as great in men as in women.[1] Here at the outset we are confronted by a remarkable contrast. But, allowed to stand as here stated, it involves a vital error. A propensity to crime is its existence latent in the possibilities of the individual. Justin McCarthy, in one of his novels, in describing a character defines her virtue as purely anatomical while mentally most unchaste. Here the

[1] Quetelet, "A Treatise on Man," p. 70.

propensity was one thing and its physical expression another. It therefore follows that if we are to reach the degree of woman's propensity to crime it must be by other means than a simple expression of the difference in the actual perpetration of total crime. The propensity can be approximately measured by the degree of the offense. Quality and degree are in law the measures of the punishment inflicted on the offender. This is called justice, and it is indeed tempered with mercy when we compare it with the operations of law less than a century ago, when it dealt with crime simply as a quality without reference to degree. In its treatment of criminals, society took its first scientific stand-point when it measured the propensity to evil by the degree of evil actually committed. It seems safe to assume that in a certain limited range, as the degree of crime defines its penalty, so also it expresses the extent of the propensity. Another fact may be approximately established from the same data. The causes of crime, those deeply-hidden undercurrents existing in society, the ebb and flow of which seem to register themselves in undeviating curves of human conduct, must vary in intensity to the degree of crime which is their natural outgrowth. Thus, a man who commits a criminal act with the full knowledge that his life is jeopardized thereby must surely be exposed to an influence far greater than one who, under all circumstances, would shrink from the greater crime through a sense of punishment, but would not hesitate to commit a lesser offense. If this is not so, then society has been acting upon a false theory in its repression of crime by the fear of punishment. But I believe legislation for this purpose has been based upon a correct knowledge of human nature, and that the average man with criminal tendencies is, to a certain degree, deterred from criminal conduct by a fear of punishment. There is strong confirmation of this in the condition of society existing in the border States and mining regions, in which there is a low estimate of the value of human life, not from the fact that life is individually less precious there than elsewhere, but that the tendency to this form of crime exists in greater force as a natural outcome of the conditions under which human life is there grouped. I believe it is just, therefore, to partly form an estimate of the tendency to crime by the method I have adopted, aided by a simple comparison of the prevalence of crime in general in the sexes.

The apparent great excess in the prevalence of crime among men forms one of the most interesting facts of sex in crime. At the outset we ought to reach, if possible, the cause. In this connection all ideas of the innate morality of women over men must be abandoned. Modern literature is full of a false and even morbid idea upon this subject. M. Michelet has written a romance called "Woman,"[1] and it is a fair sample of what may be termed the sentimental estimate of the sex. But the frail creature portrayed in the florid sentences of Michelet

[1] "Woman," from the French of M. Michelet, by J. W. Palmer. New York, 1874.

is not the woman of France. One glance at the tables of Quetelet proves this.

We must take a practical view of woman's character. She must be regarded as one in whom the passions burn with as intense heat as in the other sex. The limits of her morality are the same as man's. She attains purity in the same manner; and she meets sexual disaster through the same means. Her worldly view is bounded by the same horizon. She upholds for herself the same standard of success or failure. Temptations run in the same channel and are resisted by the same psychical traits. The forces of heredity play the same *rôle* in her mental and bodily life. Beyond these, she belongs to a different mental type from man, the effects of which in our present knowledge, and in the relations we are now studying the sex, reach limits impossible to fix. I can see no other way of viewing the sex, and reaching any thing like approximate truth in her relations to crime.

In crimes against persons in which personal strength forms an element, there is a physical factor for the difference. The ratio of strength between the sexes is as sixteen to twenty-six, and this is found to correspond to the difference in which women and men participate in crimes against persons and property.[1] Such a coincidence as this, constantly recurring, renders, in this broad classification of crimes in general, such an explanation probable. But, in a closer analysis of crime in particular, this physical basis loses its value as a probable cause. While we must allow that sexual difference in strength finds a reflex result in consciousness, and thus places a limit to the acts of either sex, yet in crimes against persons we find the sexes approaching to and receding from a common ratio. It is this fact which leads me to the conclusion that all argument regarding the innate excess of moral qualities in the female sex over the male, is based upon a fallacy. It is strongly confirmatory of this, that a simple numerical comparison of the prevalence of crime in the sexes leads to error, unless we credit women with the fewer temptations, the less opportunity, and those forms of sexual cerebration which find their expression in a want of belligerence which characterize women. Thus it would be obviously wrong to assert that, because twelve women to one hundred men are convicted of assassination, women represent more than eight times the morality of men in relation to this one offense. This crime is just the one to call into play all those conditions which constitute the moral atmosphere and conditions of sex. Woman's want of opportunity, the nature of her occupations, and the absence of the same degree of temptation, must all be taken into consideration in forming an opinion of the moral equivalent of women in connection with the crime. If it were possible to give to each one of these modifying conditions a numerical expression, this moral equivalent could be given a mathematical value. But this is impossible, and each possesses in itself

[1] Quetelet, *loc. cit.*, p. 91.

an imaginary yet appreciable value. Again, let us group all those crimes against persons which involve the taking of human life, and observe the extent to which the sexes are engaged. For all crimes against persons, Quetelet places the ratio at sixteen to one hundred; but in the class of crimes I have selected, involving infanticide, poisoning, parricide, assassination, and murder, we find this ratio nearly doubled, being thirty to one hundred. It is evident that woman's tendency to crime must be measured by some other standard than innate morality. If we apply to these figures the theory that the degree of crime is in a measure the test of propensity, we obtain some startling results. Take the felonies named above in the aggregate, and while the marked difference of sex in the commission of total crime is evident, we see that in the perpetration of these grave offenses she exceeds her ratio of crimes against property. I think this shows the probability that those emotions or passions which serve as the incentives to crime, approach in intensity the same mental conditions in the other sex. When we consider the strong emotional nature of women, and that many of these emotions are of an organic or sexual origin, and their social relations, and the habit of dependence, which they have inherited, upon these relations, we must admit that the moral elements of crime are so strengthened as to modify materially their deficiencies of strength and want of opportunity.

Many of woman's social relations are well calculated to clear and make easy the way to crime. It is another confirmation of the fact that society prepares the crime, and the criminal executes it. Compensation is found for her in the fact that society also places obstacles in her way by removing many temptations and opportunities for offense. But, in those crimes which are the natural outgrowth of her sexual and social relations, we find woman standing upon man's own level as a criminal. Thus, in infanticide and in poisoning, both of which, from the degree of offense involved, show a strong action of the exciting cause, all sexual difference in numbers disappears, and it is evident that the tendencies to those two crimes are equivalent in the sexes.

As the preceding shadows forth the interesting fact that woman, as a criminal, is under forces of both restraint and non-restraint other than sexual differences of mind or body, compared to man, it will be necessary to refer briefly to the nature and extent of these modifying circumstances, in order to appreciate the true bearings of the question. These conditions spring mainly from her social relations. This leaves us another important class of modifying conditions which may be traced to sexual relations. Two classes can therefore be made: (*A*) social conditions, and (*B*) sexual conditions, modifying woman's relation to crime.

The first (*A*) which exist sufficiently near to the subject to call for analysis are: (1) occupation, (2) opportunity, and (3) marriage;

and each of which must have a marked influence on sporadic cases of crime, and especially upon the creation of the criminal habit. But, much as these modifying circumstances have to do with the question before us, yet returns involving these particulars are so imperfect that we are able to get but a hint of the extent to which each acts.

(1.) Occupation, as it places woman above temptation to the minor degrees of crime, or as it brings her more closely in contact with constantly-recurring temptations, becomes an important factor. It is evident that these conditions must exist in the lives of both sexes, and have their influence on the frequency of crime and the nature of the offense. Thus in an official return [1] quoted by Quetelet, in which the offenders are classified by occupation, the accused of the eighth class who all exercised liberal professions, or enjoyed a fortune, are those who have committed the greatest number of crimes against persons; while eighty-seven hundredths of the accused of the ninth class, composed of people without character, as beggars and prostitutes, have attacked scarcely any thing but property. When the accused are divided into two classes, one of the liberal professions, and the other composed of journeymen, laborers, and servants, this difference is rendered still more conspicuous.[2] This is sufficient to render the broad inference probable that want or necessity induces but the minor degrees of crime against property, while the more serious phases of crime belong to the opposite conditions of society, or have their mainspring in other motives. In the *Compte Général de l'Administration de la Justice*, the occupation of the accused is given by sex, and under the article *Domestiques* we find one hundred and forty-nine men and one hundred and seventy-five women employed as personal servants, nearly all of whom were accused of the minor degrees of crimes against property. These proportions for this occupation hold about the same relations from year to year. As persons so engaged are maintained generally by their employers, want could not have existed as a motive for these offenses. Cupidity, or the desire to appear well, with the facility of its gratification, afforded by occupation, is the probable motive, and, making allowance for the slight excess of women so employed, exists in almost equal intensity in both sexes.

From what we know of the inadequate pay attending many of the employments in which women are engaged, it is safe to say that irresistible temptation is often the result. In the larger cities there are thousands of women, reaching from youth to advanced life, who are but just able to provide themselves with the necessities of life by labor extending over more than half of the hours in the day. Many of these have others dependent upon them, which must add very much to the tendency to the minor forms of crime. But the tendency to crime arising from inadequate pay is twofold. It may not be sufficient to meet necessary bodily wants, or barely sufficient, or, as is too gen-

[1] "Rapport au Roi," 1829.

[2] *Loc. cit.*, p. 85.

erally the case, it is insufficient to supply those matters of personal adornment and comforts of surrounding, small as many of them are, which are so necessary to contentment. This tendency to adornment either in person or surroundings must be looked at seriously as a sexual mental trait in women. They need but to reach the rudimentary stage of education to have developed in them æsthetic tendencies, and which in many seem to exist innately. This feeling is also closely allied to that personal pride which is such a safeguard against the encroachments of vice. This pride of person is to many a struggling woman what a moral atmosphere is to others. To the one it is an instinct which keeps her from the degradation, and that conduct which leads to it; to the other it is the moral force which surrounds her and lifts her above the opportunities for evil. Viewed in this light, personal pride, as expressed in the adornment of person and home, may replace the purely moral sense to a certain extent. But pushed beyond the point at which it contributes to correct conduct, and allowed to exist solely as a sexual trait, it may become a strong incentive to crime. There is no reason to doubt but it is mainly the cause which makes crimes against property so nearly equal in the sexes among French domestics just alluded to. A mere desire for luxury would not be liable to develop in one never at any time of life exposed to its enervating influence, as the mass of working-women spring from parents who are also toilers, so that we may safely conclude that want, or a personal pride to appear better than others in the same station, is the most active cause of crime among underpaid women who have inherited no criminal taint.

The massing of large numbers of women at manufacturing centres is a circumstance from which spring many conditions which render the minor degrees of crime easy of commission. It is a singular fact that a great preponderance of numbers in one sex over the other, unrestrained by ties of family, and without the natural dependence of the different occupations and stations of life upon each other, almost invariably defines a locality in which the various forms of crime exist to excess. This has long been remarked of places in which the number of men greatly exceeds the number of women, but little attention has been called to the same condition as resulting from the preponderance in numbers of the other sex. Any one who has inquired into the causes of the social evil must have been struck by the numbers who admitted they had taken the first steps of their career in the populous manufacturing towns where an excessive number of their own sex was employed. There is this marked difference: an excess in the number of men leads to an increase of crimes against persons, while an excess of women increases crimes against property, in both cases relatively as to sex. I see no way, in our present knowledge of the subject, of explaining this, other than that a healthy tone of society demands an even balance of the different occupations and stations,

and the presence of those ties of kinship which act so powerfully as restraints. Aside from these conditions I know of no facts which show that an even proportion in numbers of the sexes has a mutually conservative effect upon morals.

Generally, those in whom there is no inherited criminal taint, or no development of the criminal habit, would not seek nor create an opportunity for offense. But this can hold true only as to crimes against property, for in the other class of offenses, revenge, jealousy, avarice, and other emotions, may act suddenly as the exciting cause.

It is evident that woman's opportunities for crime are restricted by her relations to society, except, as we have already seen, certain facilities are afforded by her occupation. The moral influence of woman upon society is powerful; but it is negative rather than positive. Woman wields a sort of moral inhibitory power. Except as she may directly incite the other sex to crime, relationship to woman restrains and tones down the more salient points of the male character. Her lessened opportunity for crime results naturally from her sexual relations. Opportunity springs from the free mingling of large numbers in the heat and action of life. It is the antagonism between interests and objects, the friction, as it were, between the rapidly-moving actors, which brings out the intensity of emotion which results in the open or secret warfare of society. The vast majority of women are, to a certain extent, removed by the restraints not by any means artificial, but those which naturally result from their sexual relations, from the opportunity for crime. But I would limit even those restraints to crimes against property, rather than against persons. Although the ratio is sixteen and thirty-two to one hundred for each of these classes respectively, yet I believe it can be shown that the diminished ratio for crimes against persons depends upon other and more specific causes than her sexual attitude to society. Domesticity in this relation shows its potency as a conservator of morals; but, standing alone and unaided by mutual dependence and interest, its power is limited to placing each subject beyond the more closely-besetting opportunities to which men are exposed. It is but necessary to call attention to the fact that it is from among female domestics and operatives that the ranks of prostitution are recruited, in order to show that domesticity, which is the condition of seven-eighths of the female population, must be accompanied by other relations in order to act as a more or less complete restraint to crime. I use the word here in its broadest possible sense, as defining the position of the majority of the sex. Great as the influence of the domestic relation is, it is limited by the fact that it is not permanent. It is constantly exposed to those accidents to which all human relations are liable. The passions and discordant interests find in this relation a field for their utmost activity. The sexual relation, which is founded in the passions common to us all, finds in them the ele-

ments of its strength and permanency, as well as its weakness. It is created and made lasting as life, or as brief as a summer's day, by one and the same organic emotion. Otherwise marriage, which we may assume as the type of domesticity, would not seem of itself to exist as a factor in crime. As we study marriage in relation to crime in another part of this paper, we shall perceive some very singular facts in which its bearings upon society are not so healthy as might be expected. It cannot be charged, however, to marriage, which is the most perfect of all human relations, but to its underlying weakness, the changing sexual conditions upon which it is based. It is safe in a broad grouping of crime to say that the emotions and passions define offenses against persons, while those against property are characterized by processes of mental calculation and deliberation. The last needs opportunity and temptation; the first exists everywhere. The domestic relation affords a refuge to the one, and contains within itself the element of the other. For these reasons I believe that the restraint afforded by domesticity must be mainly limited to crime against property.

In connection with this division of our subject we are brought face to face with the fact that women are as capable of crime as men. "It is not the degree of crime which keeps a woman back," says Quetelet .... "Since parricides and wounding of parents are more numerous than assassinations, which again are more frequent than murder, and wounds and blows generally, it is not simply weakness, for then the ratio for parricide and wounding of parents should be the same as for murder and wounding of strangers." [1]

With opportunities equal to man's, with the way to crime made easy, instead of being hedged in by the limits of her occupations, woman may equal him in the tendency to crime. Infanticide, in view of the strength of woman's maternal emotions, of the acuteness of her sympathies, and the general attributes of her character, stands alone as a crime in its relations to the sex. Considering the violence done to emotions which are a part of her organic psychical life, it has no equivalent in degree in the range of crime. If we apply to it the theory that the degree of offense, to a certain extent, affords a measure of the tendency to crime in the individual, this crime would reveal in women such a tendency greatly in excess of the other sex. But we must bear in mind that this crime, more than any other, which tends to make woman appear unduly prominent as a criminal, is a natural outgrowth of social surroundings. It is a marked instance of the fact that society contains within itself, even in its normal conditions, the moral agencies that create crime. Society has raised for itself a gauge of conduct, by which the alternative may be presented to any woman, of either crime or disgrace. At the same time society has so organized itself that the chief aim

[1] *Loc. cit.*, p. 91.

of every woman has been to establish a permanent relation to some man based upon involuntary sexual emotions. So long has this been in existence, so much power has it acquired by the increment of the forces of heredity, that it has become an organic law of society. This is a factor which enters into every woman's existence; by it her sexual life is made to exceed in intensity the intellectual. Ceaseless indwelling upon what every woman is taught to regard as both a necessity and an honor has tended to give undue force to every thing that relates both mentally and physically to her sexual existence. This is the manner in which society has made the way easy for woman's sexual error. Reflecting upon this, I confess to admiration for a sex which in the face of these difficulties has ever maintained such a well-deserved reputation for purity, and shown us that mankind turns instinctively to good rather than evil. Punishment is part of the crime, with society. To women for a sexual offense it measures out a punishment relentless and life-long. They are banished and hang on the outermost skirts of the inexorable law-giver as "Scarlet-Letter" ones, for whom, in all their lives, there is no further hope.

Prepared in this fashion for infanticide, can it be wondered at that the ratio for this crime is 1,320 women to 100 men?[1] It is clearly an alternative of either social banishment and a total defeat of her selected destiny, or an attempt to conceal her error by crime. With an obliteration of one set of moral feelings there must be necessarily a weakening of the general moral character. She is therefore prepared to violate all the emotions and consciousness which have their origin in the very condition, through the undue development of which she met disaster. Infanticide appears to the woman's consciousness less formidable and repellent than her certain punishment by society. Her training has prepared her to place this lessened value upon the crime. Quetelet gives prominence to shame as an impelling motive to the crime. I can give it no such value. That sense of shame or modesty which exists as a phase of sexual cerebration in every mentally healthy woman, and that induces her to guard so jealously the casket after the jewel has been stolen or rather bestowed, is the part of her mental life to which the most violence has been done by her social error. What the French philosopher ought to refer to, is not the sexual quality of shame, but a sense of degradation which is common in an equal degree to both sexes. It is the sense that the good opinion of those we know, and whose esteem we value, has been forfeited. When we connect this sense of forfeiture with the fact that the interests in life which women are educated to hold most sacred, await but detection to be lost forever, I think we have found sufficient reason why this crime, which so antagonizes all womanly qualities, should exist to such a degree as to alter nearly one-half the ratio of the sexes in relation to crimes which involve human life. In ana

[1] Quetelet, *loc. cit.*

lyzing the circumstances which bear upon infanticide, we are studying the darkest page of woman's criminal history. It proves that under a sufficient motive, and with every opportunity which her peculiar relation to that offense gives, she demonstrates her capacity to equal man in both the degree and number of her criminal acts. It is, however, an offense so characteristically entwined with her sexual life, and with her relations to society, that we must have a due regard for circumstances in contrasting it with any crime or series of crime in men. As already perceived, I am disposed in this inquiry to assign it but one value: her disposition to entertain the criminal idea, and under favorable opportunity to give that idea expression. In other respects the crime stands alone, and can be used only in contrasting woman against woman. There are certain abnormal states of sexual cerebration connected with this offense which will more readily present themselves when we study the crime against society—the social evil.

In considering the effect of married or celibate life upon women in relation to crime, we are beset by many difficulties in regard to data. The officials upon whom devolve the duty of collecting criminal statistics, have yet to learn that they deprive their labor of much of its scientific usefulness by their errors of omission. The information has but little value that so many male or female criminals are married or unmarried. A proper study of the subject requires that this information be given in its relation to crime as it affects persons or property, the age at which the criminal career began in the two classes respectively, and crime among the widowed or divorced. Nearly all these facts are wanting. We can, however, collect sufficient data to enable us to shadow forth the probable truth in regard to this important matter. We may safely term marriage the unit of force in our present civilization. I have briefly called attention to its innate strength and weakness, which are inseparable from human mutability. It is easy to perceive the manner in which marriage may act as a conservator of morals, and its operation as a promoter of crime is equally evident; but the extent of its operation in either direction is difficult if not impossible to measure. In the examination of the returns of crime for the years 1867, 1871, and 1873, in New York City,[1] and which show great uniformity in the social condition of the sexes, we are met with the strange fact that the percentages of the married of both sexes correspond, being thirty-nine per centum; while for males the percentage of the unmarried is fifty-five, and for females in the same social condition it is forty-two. Regarding marriage as a conservator of morals in its affirmative rather than its negative relation, this statement places man on a level with woman; but observing further that the excess of male criminals is furnished from the unmarried,

[1] Table "B," 23d and 27th, and Table "A," 29th, "Annual Reports of the Prison Association, State of New York."

and that the single and married female criminals exist in nearly equal proportions, we can reach but one conclusion, that marriage exists as a restraining influence against crime more strongly among men than women. I think this result is opposed to the preconceived opinion of the majority, of the effect of marriage upon women. Marriage for women has ever been regarded as a preliminary condition to reform. This is the result of the sentimentalism which has entered into the solution of many social problems. Marriage is not unmixed good. Lecky says of it, that "beautiful affections which had before been latent are evoked in some particular forms of union, while other forms of union are particularly fitted to deaden the affections, and pervert the character."[1] Woman's keenly emotional nature is well disposed to be exalted or depraved by marriage. It seems hardly possible to reach the true causes of the nearly negative results of marriage upon the morality of women by a study of the character of this sex alone. In women, rather than men, are mirrored the lights and shadows of society. Mentally she is the plastic material which takes its form from the protean phases of life around her. She is spiritually the resultant of her moral atmosphere. I believe these influences are more potent in forming her character than man's, from the nature of her dependent circumstances. With man's opportunity for objective life, he can remove himself, partly at least, from the moral surroundings; and by identifying himself both bodily and mentally with labor, which has for its object, usually, something to be attained in the future, he has loop-holes to escape from impressions received from others, which with a more subjective life would result in introspection, by which the mind is familiarized with the criminal idea.

From the same source we may gain additional facts as to the negative effect of marriage upon the morality of women. In the tables referred to, involving in the aggregate an excess of males over females of about two to one, we find the number of widowed females over males in the same social state to be nearly double. It is impossible to state specifically the nature of the crimes involved in this excess; but it probably represents, in a great measure, offenses against property. The social condition of widowhood in the average woman is not conducive of morality; and yet we have already shown that actual marriage is attended with nearly negative results. From this we may gain an idea of the extent to which women are the victims of circumstances at the beginning of their criminal career. The figures we have been analyzing represent crime in a great city. Under this condition, the excess in the number of widows represents probably cases of complete destitution. The fact that this excess of widows had no means of coping with this difficulty, except by a resort to crime against property, renders the conclusion safe that not only marriage had not developed in them a condition favorable to morality, but had actually

[1] *Loc. cit.*, vol. ii., p. 369.

so lowered the moral tone as to render them unfit, as a class, to contend with the difficulties of life, and exhibit the same degree of morality as the unmarried woman. Much of this result must depend upon the unavoidable social position of the married woman—one not at all calculated to test either her morality or self-reliance. The duties of maternity and domesticity inseparable from her position, do not fortify her against evil in her changed relation to society. On the contrary, with the burden of children upon her, in the time of need, she looks upon crime less as a positive than as a comparative evil. With the true woman, there is no chance for hesitation in the choice between crime in its minor forms and her maternal feelings. But the marriage relation has other influences in forming woman's character as a criminal. The intimacy of the wife with a bad husband, who, if not a criminal, at least may be capable of infusing lax moral notions in the wife, would, if she were left a widow, surely bear fruit. We need a more intimate knowledge of many facts in order to fully understand this question of widowhood in its relation to crime. It is doubtful if returns of crime from less densely populated places than New York City would furnish results at all parallel to those in relation to widows. The most plausible explanation I can give is, that these figures represent cases of absolute destitution.

There are many other relations that marriage bears to woman's career as a criminal, but which are beyond the scope of a magazine-article. All that relates to infanticide, and the prevalence of the crime of the period, among the single and married, ought, I believe, in writings of a popular character, to be omitted, except possibly the grave words of warning. Upon this subject I have written all that I thought prudent several years ago, and to which I refer the reader.[1] The well-known lines of Pope upon the effect of familiarity with vice, are certainly very true to-day. It is by a too familiar view of even the shadow of crime, that in certain minds the criminal idea may be developed. We need but abolish the mental barriers to crime to step from the criminal idea to the criminal act.

Instinctive recoil from the criminal idea without any mental reservation is the characteristic of moral health. It is upon the morally healthy minds that unfavorable social conditions may have most deplorable effect. One in whom the tendency to crime exists as a latent mental quality, requires no social conditions for its development. Whatever his or her occupation or social condition may be, this latent quality is liable to assume active existence, and shape the destiny of the individual. There is one quality that the criminal exhibits which defines him as a class, and is the only trait by the existence of which he becomes the member of a class. This is the liability, after the first outbreak, to commit repeated offenses. I find no term which expresses

[1] "The Detection of Criminal Abortion, and a Study of Fœticidal Drugs." James Campbell, Boston, 1872.

this so well as that of the criminal habit. Mentally and physically we are the victims of custom. Existence, like running streams, has a tendency to find for itself fixed channels. Life as it expands seems to seek points of least resistance for its outlets, and in following which it encounters less friction to retard its flow. In relation to crime, this exists as strongly as the opium or alcohol habit. The habit may find its factor in perverted moral feeling, whether hereditary or acquired, but its physical expression becomes the rule of life. Take such an instance as that of Ruloff, to whom Nature had given the crude material of a magnificent mind. In spite of the terrible potency of his criminal ideas, a longing for a nobler and higher life existed within him in sufficient force to give direction to considerable self-culture. He stole, and would kill without remorse any one who stood between him and his object, simply to gain money to enable him to follow his studies. His life took the direction of the least resistance. That which existed in the normal man as a sense of right or wrong, and offered itself as an obstacle to wrong-doing, had no place in this man's mental life. The outgoings of his life in the direction of least resistance, simply and naturally led him to crime. Cerebral and bodily activities, among the good and bad alike, follow the channels in which they encounter the least friction, either objectively or subjectively. It is thus we have the parson and the thief. By inherited traits, early training, occupation or social condition, weak points may be created in the barriers which surround the activities of life, and when maturity is reached the individual's existence is defined by ineffaceable lines. At this stage of life, efforts, made either from within or without, to give a new direction to these channels, come too late. Habit has been established which confirms the direction life has taken. These two forces united seem irresistible. I was, several years ago, brought in contact with an instance which proves this. Lena S—— was of German descent, and about fifty years old. She was of more than average intelligence, and of spare, nervous temperament. Lena was an instance of sporadic crime, in the sense that she did not belong to a criminal family. She followed the specialty of shoplifting, one that requires great coolness and cunning. Caught in the act and arrested, her history was brought out. She was married, and her husband was serving out a term of imprisonment, but with whom she had not lived for many years. She wandered from city to city, following her business; she had been repeatedly arrested, and more than once punished, and every time her whereabouts was brought to the knowledge of her family by her arrest, attempts were made to reclaim her, but in vain. Sentenced to several years of imprisonment, she quickly began to droop. She passed sleepless nights, with quick, irritable pulse, and loss of appetite. She constantly brooded, and laid more than one plot to escape, one of which was nearly successful. Out of about a year and a half of confinement, not more than a month of light labor was

exacted of her. Her health became so broken that, at the earnest solicitation of her relatives, the prison authorities took the case up, and secured her a pardon on condition that she left the State, and her relatives provided for her. But the transition from prison-life to the comforts of a home, and a life of ease, offered no attractions to the unfortunate woman. I believe she remained under the care of her relative—a devoted sister—but a few months, when she resumed, out of choice, her old mode of life, and is now serving out another sentence.

This case shows how irresistibly the deliberate acts of life flow in the channel which habit and mental traits mark out for them. The barriers which society, and fear of punishment, and love, place in the way of a career like this of Lena S——, are swept away, as it were, before a flood. This is the destiny of the fatalist, and the force of habit, an expression of the theory of least resistance, and the effects of heredity of the sociologist. Let us analyze the last case further, to illustrate the theory of least resistance, as modified by occupation and social condition. It presents a seeming contradiction. She moved on in her career of crime late in life, with her moral atmosphere charged with resistance to her progress. Contrasted with this was her criminal pupilage in early life. Her husband united pauperism and crime, and if originally her moral perceptions were clear—which I doubt—she thus found the best school to obscure these, and familiarize her with the criminal idea. With these faculties blunted and weakened, which serve to hedge in the impulses to evil, she proceeded to supply her wants by the method most familiar and easy. The thief looks upon the property of others in a peculiar way, and one that constitutes the essence of the crime. He believes in a sort of ownership which is mutual, and depends upon possession. This belief may become a fixed habit of mind. Originally it may have been easier to steal than to work, later it may become more impossible to work than to steal. Then came attempts at reform, made by others, with the life of ease and comfort, but the criminal grew wretched and drooped. There was but one life before her which met the demands of her nature—that was to wander from place to place and steal. This woman answered in no sense to the legal definition of the insane; she was not irresponsible for her acts, she knew their nature and the punishment which followed detection; but she simply did that which the most of us desire to do, follow the easier and pleasanter life. It has become the fashion of late to speak of criminals of this class as insane, but this theory cannot explain their irreclaimable condition. The real state, as it appears to me, is, that thoughts and acts move in the direction of least resistance. What began in this way, may be confirmed by habit, so that life may wear for itself channels from which it is impossible that its current may be driven.

HYDROIDS.

By Mrs. S. B. HERRICK.

SOME of the most exquisite forms of organic Nature are to be found in that shadowy border-land which unites rather than divides the animal and vegetable worlds. It is hard to believe, even when looking with careful scrutiny at certain forms of animal life, at

Fig. 1.—Plumularia falcata. (Natural Size.)

the corals, for instance, the sponges, and the hydroids, that an existence which so closely resembles vegetation should be essentially ani-

mal. Each of these families of the great invertebrate kingdom has been bandied back and forth from the botanist to the zoölogist, and each has finally found its place in the animal world.

No purely empirical knowledge is sufficient to determine, among the lower forms of life, to which kingdom they should be referred. It is only by studying facts in their relations, by patiently observing the life-history, and by ascertaining the modes of nutrition and reproduction of each form, that its true place in the organic world has been determined.

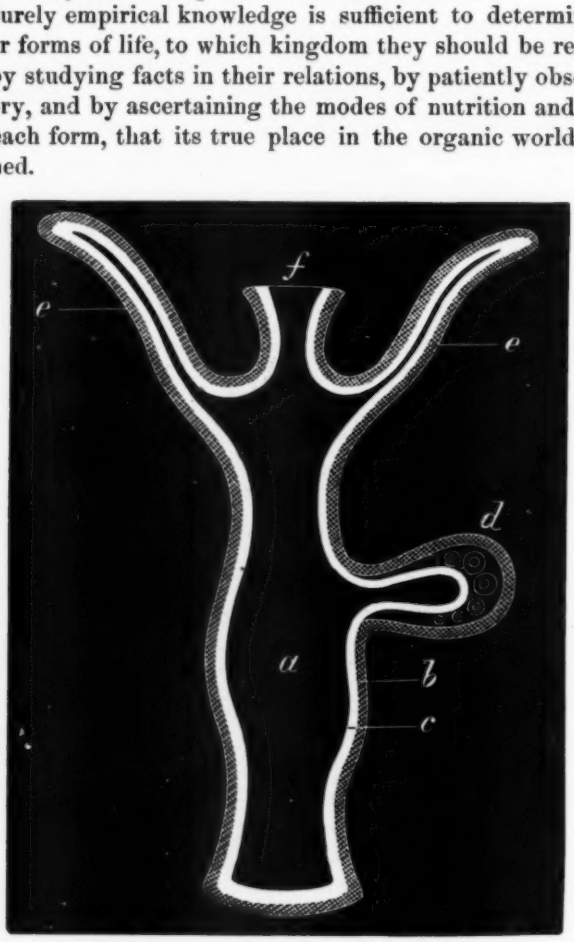

FIG. 2.—DIAGRAM OF A SECTION OF HYDROID.

It was, for many years, thought that, beyond the depth of 300 fathoms, organic life ceased to exist in the ocean. Forbes reached this zero of life in the Ægean Sea, and the fact ascertained for the Mediterranean was inferred for all other seas. The transmutation of inorganic into organic matter is only performed by vegetables, and then only under the controlling power of light. The distinction made by naturalists between the lowest forms of animal and vegetable life lies just here: vegetables convert the inorganic elements of earth, air, and water, into organized matter; animals rearrange this organized matter into animal tissue. It is well known, as no light penetrates

the profounder oceanic depths, that no vegetation can exist there; an absence of animal life was therefore inferred. Certain exceptions to this definition of vegetable life, as being exhaustive, are found in the *Fungi*, which germinate and grow in darkness, and it is believed are nourished in great measure by organic matter, as well as in the curious carnivorous plants, which have of late attracted so much attention. This, however, does not invalidate the truth that all nutriment, in order to be fit for the maintenance of animal life, must pass, at least once, through the transmutation effected only by vegetation.

The non-existence of life below 300 fathoms, in all the oceans of our globe, was strongly supported by Forbes's investigations in the Mediterranean. The abyssal depths of the sea were thus determined by logic to be the universal empire over which reigned darkness, des-

FIG. 3.—NUTRITIVE BUD OF TUBULARIA INDIVISA. (From Male Colony.)

olation, and death. No investigations were made as to the facts of the case. Logic and a hasty generalization from inadequate knowledge were made, once again in the history of science, to do duty for the more laborious method of patient observation. Commerce at last gave the impulse to deep-sea exploration, which had before been lacking. The commercial world demanded a more speedy mode of communication from continent to continent, and the response came in the form of the submarine telegraph. Thousands of soundings were made to determine the best position in the ocean's bed for its successful laying, and thousands, again, to secure the broken end after the

first failure. These soundings and grapplings brought from the sea-depths unmistakable proof that life in many varied and exquisite forms existed there, far away from light and vegetation, under an enormous pressure of superincumbent waters; and logic retired discomfited.

The fact that the Ægean Sea is empty of life in its greatest depths is due to local causes. The humblest life, in the farthest recesses of the ocean's bed, is, in some of its essential features, but a sluggish copy of the higher types on land. Food and air are alike necessary

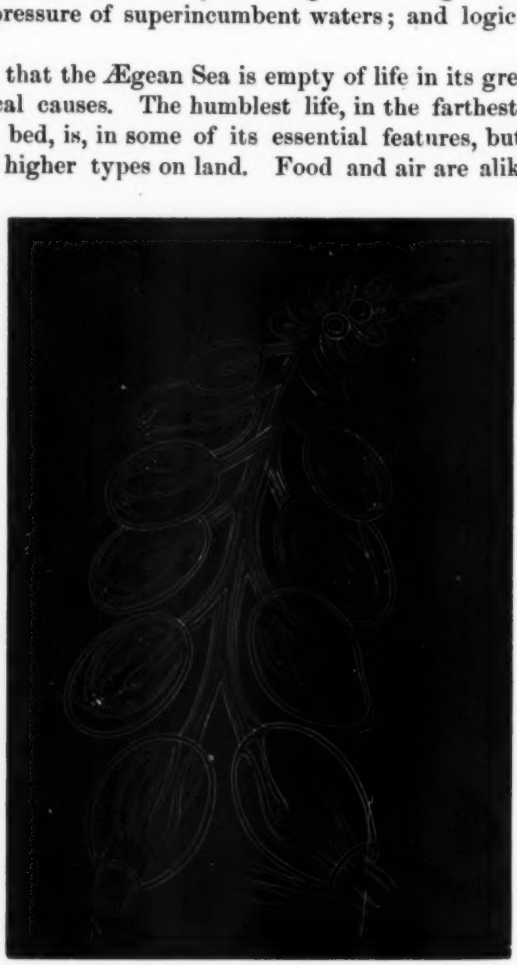

FIG. 4.—GENERATIVE BUDS OF TUBULARIA INDIVISA. (From Female Colony.)

to both. The circulation of currents throughout the open seas bears nutriment and oxygen to the lowly forms of animal life which lie far below the level penetrated by light, or capable of supporting vegetation. In the Mediterranean such currents are obstructed by the high rocky wall which runs under the straits of Gibraltar, from Spain to Africa. The lowest point in this wall is 10,000 feet above some portions of the bed of the Mediterranean. The currents in this sea are therefore superficial, as well as the life sustained by them.

Chemical analysis proves that the water of the open seas contains

both organic matter in solution and oxygen; and that this same water, after having passed through the bodies of these lower forms of animal life, is deprived of both its organic elements and its oxygen. The theoretic difficulty which had determined the problem of life in the depths of the sea was thus removed; for, given this lowest form of animal existence, the higher are always possible.

The same awful cycle of life, death, decomposition, and life again, which is again and again repeated among the higher organisms, is found working itself out as inexorably in the oceanic depths. The elements which are appropriated from the mighty reservoir of the ocean for the maintenance of the life, are restored to it again by the death, of each organic being.

The bed of the ocean, from the tiny lakelets left by the retiring tide to the greatest depths ever reached by trawl and dredge, is found to be teeming with exquisite forms of life. Delicate plant-like forms are found clinging to rocks and shells, or spreading themselves over the broad fronds of the algæ. Every peculiarity of vegetation is mimicked; graceful stems rising from tangled roots send out branches which bear raceme-like clusters of buds, and delicate bells whose beauty no words can describe.

FIG. 5.—ROVING MEDUSA OF TUBULARIA INDIVISA. (Magnified.)

A hundred and fifty years ago nothing was known of these beautiful hydroids. The first investigation deserving the name was made by Abraham Trembley. This man was born in Geneva in the year 1700. While residing at the Hague, as tutor to the sons of Count de Bentinck, he made a series of remarkable observations upon the fresh-water hydra. The results of his observations were published first by Réaumur in 1742, and two years later by himself. In 1727 Peysonnel had paved the way for Trembley by proving the animality of the corals. Jussieu visited the coasts of Normandy to investigate the coral question, after Peysonnel's publication of his views, and there conclusively demonstrated the animality of *Tubularia indivisa*, one

of the loveliest of the hydroid family. The hydroids are among the coral-makers. The vast beds of millepores found about the Pacific islands and the West Indies are the work of an animal allied to *coryne*, one of the Tubularians. The chitinous investment of the Sertularians also forms membranous coral of considerable size and great beauty. It was some time, however, after the discoveries of Peysonnel, Jussieu, and Trembley, before the great authorities of the day, Réaumur and Linnæus, gave in their adhesion to the animal theory, and stamped it as correct. Since that day some of the world's greatest naturalists have made the study of the *Hydroidæ* their life-work, and have not felt it an unworthy occupation to be the annalists of this humble family.

The nomenclature of the hydroids is still so unsettled that we will avoid as much as possible the use of scientific terms in describing the different portions of the colonies and their respective functions, for it is here that naturalists differ, not in the names of the varieties.

The hydroids measure from a few lines in height to several feet. Dana mentions an East Indian species which grows to the height of three feet; while Semper describes a gigantic *Plumularian*, which forms submarine forests extending over great areas of sea-bottom, and growing as high as six feet. The stems, he says, sometimes measure an inch in diameter at the base. *Tubularia indivisa* grows to the height of about ten inches.

The *Hydroidæ* are divided into four families: *Tubularinæ* (Figs. 3, 4, 5, 6), *Campanularinæ* (Fig. 10), *Sertularinæ* (Figs. 1, 7, 8, 9), and *Hydrinæ* (Fig. 12).

Every hydroid, however greatly the species may differ in external form, has a certain structural plan to which it adheres in all its modifications. The general type (Fig. 2.) may be simply described as an animal sac whose walls are composed of an inner and outer membrane. The outer wall corresponds to the skin, the inner to the lining of the stomach, in higher organisms. The simple elongated sac is not only the simplest form of hydroid, but is generally the earliest phase in the development of the more complicated forms.

The sac (Fig. 2) sends off branching processes, *e e*, and cœcal protuberances, *d*, throughout the extent of which the inner and outer membrane is continuous. Sometimes large numbers of these stems proceed from a basal net-work, the connection between every part of the animal colony being kept open through this basal reticulation, and the continuity of the two membranes being maintained intact. The basal portion, with the stems, branches, and the flower-and-fruit-like clusters, of this curious organism form the *hydrasoma*, as it is called by both Huxley and Allman.

The simple, sac-like form of the hydroid is the lowest term in a series which consists of an almost infinite number of terms. We find in this family the same orderly sequence which marks organic Nature

everywhere. While the ideal type is adhered to, and a morphological unity may be proved, yet there is an orderly and beautiful gradation, in which each form becomes more complicated than the form which precedes it.

The clusters of buds (Fig. 4), and closed or open flowers (Fig. 3), are really individual zoöids, bound into an organic unity by a basal reticulation. With a single exception, every hydroid, at some period of its existence, lives this social life, being united with a number of other individuals into a plant-like group, and is really only one of an assemblage of zoöids possessing a common circulatory and nutritive system, the individuals of which are in organic union with each other.

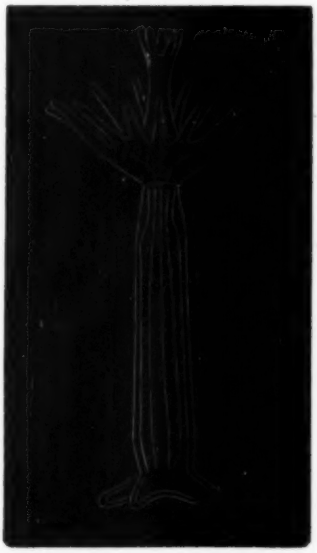

FIG. 6.—MEDUSA OF TUBULARIA INDIVISA. (After it has permanently fixed itself.)

The zoöids springing from one common base are of two kinds, and perform for the community two special offices. The grape-like clusters contain the generative elements, both ova and spermatozoa, while the flowers provide for the nutrition of the whole colony. These zoöids, which each investigator names according to his peculiar theory of scientific nomenclature, we will call nutritive and generative buds; the nutritive buds being destined for the preservation of the colony, the generative for the perpetuation of the species. The attached extremity of the animal in the fixed, or its equivalent in the free, species is called the proximal end, and the opposite extremity, which bears the two forms of buds, the distal end of the hydroid. The terms upper and lower cannot be used, because some varieties grow erect, while others grow in an inverted position.

The nutritive buds consist of an open digestive sac (Fig. 2);

around the mouth is a series or several series of tubular offsets, ranged radially about the stem. The shape of these blossom-like zoöids varies in the different species. In some varieties they are unprotected, while in others the tentacles may be withdrawn into a horny, cup-shaped sheath. The number of tentacles varies with the different species. The plates of *Tubularia indivisa* and *Hydra vulgaris* show the tentacles expanded. The other plates give, in the magnified portions, only the chitinous sheath, into which the polyp has withdrawn itself.

In the Plumularians, a branch of the Sertularian group, curious little cups of the horny sheath are developed. Unlike the cups which contain the living flower, these extensions are filled with the sarcode, or soft, gelatinous flesh of the animal. This sarcode, or protoplasmic flesh, acts like the flesh of the rhizopods and amœbæ; long filamentary processes are extended, just as the rhizopods improvise legs or arms when they need them, till sometimes the horny sheath is invested in this living gossamer. The function of these cups is not known. Allman considers them as special zoöids, whose morphological differentiation from the other zoöids is carried to an extreme. Hincks believes them to be a lower form of life, in organic union with the higher zoöids of the hydroid colony.

The horny sheath, which is described by earlier writers as an excretion, is by Allman considered to be rather the result of metamorphosis of tissue. In many varieties the stem and branches of the creature are slender, horny, and pipe-shaped, and the chitinous sheath is jointed at regular intervals, the joint being a mere break in the continuity of the chitine, not a movable hinge; while the living pulp within forms a continuous body, and is invested by its sheath as the pith of a plant is invested by its stalk.

The generative buds are cæcal offshoots from the body, the reproductive elements always developing between the inner and outer membrane (*see* Fig. 2, *d*). They sometimes, after development, free themselves from the parent stem, and lead a roving life as medusæ. In some cases the nutritive bud has its alimentary function suppressed, and, though not itself sexual, it is henceforth destined to produce sexual buds, either directly or through the medium of a non-sexual bud.

There is, it may almost be said, no differentiation of organs among the hydroids. In the adult form they possess no organs of sense, and have no circulatory, respiratory, nor nervous systems. All the functions of life are performed without the intervention of special organs. Voluntary motion takes place without muscles, sensibility is present without nerves, respiration is performed without lungs, and digestion goes on without a true stomach. The sea-water which flows within and about the creature bears to it the oxygen necessary to the maintenance of vital combustion, as well as the small living creatures and comminuted organic matter which form its food. Like the sea-

anemones, the hydroids reject such portions of their food as they do not assimilate through the mouth. In the fresh-water hydra an orifice has been observed at the lower extremity of the stomach. This, however, does not correspond to the alimentary canal of higher organisms; it is the analogue, in the simple hydra, of the ramifying cavity which permits a free circulation throughout the compound group.

A circulation has been observed in the varieties which possess a horny sheath, which is, however, very different in some respects from the circulation of the blood in higher organisms. The somatic fluid, as it is called, is loaded with granules which, upon microscopic examination, prove to be composed of disintegrated elements of food, of solid colored matter secreted by the walls of the somatic cavity, of cells detached from the living tissue of the animal, and of particles of effete matter. The fluid seems to be more nearly akin to chyme, or chyle, than it is to blood. There is perpetual motion in the somatic fluid; the flow will sometimes be steady for a while, and then a sudden reversal will take place in the direction of the current, before it has reached an extremity. The gastric cavity is traversed by the stream, as well as all portions of the hydrasoma. In some species the cause of the flow has revealed itself under the microscope. The cavities through which the current moves are seen to be clothed with cilia—tiny lashes whose rhythmic motion forever propels the fluid; this ciliary action is no doubt greatly aided by the contractility of the walls. In many species the cilia, if there be any, are too minute for detection; but it is a fair provisional inference that where

FIG. 7.—SERTULARINA CUPRESSINA. (Natural Size.)

the somatic flow is observed the like cause may account for the like effect.

The exquisite colors of the hydroids, which rival the tints of our loveliest flowers, are due to the colored granules secreted by the animal and discharged into the somatic fluid. A charm is added to these flowers of the sea by the flashing opalescent gleams of color which shine out from their crystalline walls. Even the exquisite representations of Allman, in his monograph on "The Tubularian Hydroids," fail to give an idea of the beauty of form and color to be found in the real object. The *Hydra viridis* is so called from its brilliant green color. This green is said by Allman to be of the nature of chlorophyll, and to possess the power, like the chlorophyll of plants, of decomposing carbonic acid, assimilating the carbon, and yielding up the oxygen. If this be true (and there is no reason to doubt it, Allman being one of the highest authorities), it only furnishes, in this form of animal life, one more curious resemblance to vegetation, and denies one more tradition of its animality.

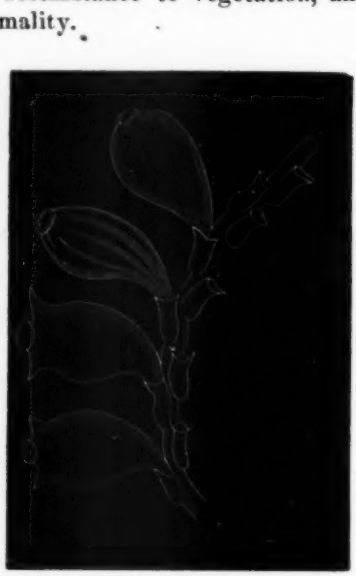

FIG. 8.—SERTULARINA CUPRESSINA. (Magnified.)

The most singular facts in connection with hydroid life lie in the variety of its modes of reproduction. It would almost seem as though every form of reproduction known in Nature had been mutely prophesied in the primeval world when the fossil hydroid and trilobite lived side by side in the Silurian seas.

They are generated, like plants, by buds and by artificial sections; like plants, they are able, from a small fragment, to produce the whole organism. They, however, go farther than most plants in this power of reproducing lost parts; for a small fragment taken from any por-

tion will suffice for the production of a new individual; a single tentacle will produce a flower and stem, and finally a whole colony. A transverse section of the stem will produce a flower at the distal end, and a continuation of the stem, with the process by which it attaches itself, at the proximal end of the section. Just so far it shows orientation—that the stem has a distal and proximal end. There is no sign of bilaterality in most species, and in others the indication is so slight that it is hardly worthy of the name. This development of the flower always at the distal, and of the stem always at the proximal, extremity of the section, shows conclusively that the stem grows both ways, and that in every segment there exists a neutral plane midway between both ends.

Besides these plant-like modes of reproduction, hydroids are generated, like the actiniæ, by spontaneous fission, a development of one individual into two or more by a natural vertical cleavage.

They multiply by ova, by ovules, by independent ciliated embryos, like the lower invertebrates, the reptiles, and birds. Some varieties possess a sort of marsupial pouch, in which the undeveloped young

FIG. 9.—PLUMULARIA FALCATA. (Magnified.)

are retained till they attain maturity; and, like the mammals, in some cases, the individual quits the parent after attaining perfect development. Added to all these modes of reproduction, in which the analogy must not be pressed too closely to those of higher organisms, they possess two very curious modes of their own; one given by Allman in his monograph, the other by Carpenter in the latest edition of "The Microscope, and its Revelations." The *Tubularian* and *Campanularian hydroids*, Allman tells us, develop upon their stems bell-shaped medusæ (Figs. 4, 5, 11), which free themselves and swim the adjacent waters. All free-swimming medusæ have not yet been traced to hydroid stems; but, as all which have been carefully studied through their life-history are found to originate there, it is supposed to be true of the others.

The most remarkable fact in regard to these medusæ is, that the immature form shows a higher type, a greater differentiation of organs, than the parent hydroid. The medusa possesses, in common with the parent, a digestive cavity and cnidæ; and, in addition to these, an organ at the base of each tentacle, which, if it does not unite within itself the senses of sight and hearing, at least is akin to those organs in the lower invertebrates. They certainly possess distinct bundles of muscles and nerve-ganglia, which are not found in the parent form. When the roving medusa has sown its wild-oats, and comes to settle down into a respectable family hydroid, it loses all these advantages belonging to its wandering life, and becomes in its later form identical with the parent; it returns to the privileges and traditions of its fathers.

FIG. 10.—CAMPANULARIA DUMOSA. (Natural Size, and magnified.)

The huge *Rhizostoma*, and the beautiful *Chrysaora*, common to the English coast, Carpenter tells us, are oceanic medusæ developed from a small hydroid stem. The embryo emerges in the form of a ciliated ovule, resembling some of the infusoria. One end contracts, forms a foot and attaches itself, the other sends out four tubular offshoots, as tentacles, and "the central cells melt down to form the cavity of the stomach." This hydra-like form multiplies in the ordinary way by budding, for an indefinite length of time. After a while, however, a change takes place, the stem shows constrictions, beginning near the distal end, till the whole stem looks like a *rouleau* of coins; the constrictions deepen, making the stem look like a pile of saucer-shaped bodies; the disks become serrated, and finally the tentacles which belonged to the original medusæ disappear, and new tentacles are formed upon the uppermost disk of the pile. Soon this disk begins to show a sort of convulsive struggle which results in its freeing itself, and swimming away as a medusa; each disk develops in the same way, and in turn separates itself from the parent stem. The original

zoöid often returns to its hydra-life and reproduces itself by budding in the old fashion, and finally becomes "the progenitor of a new colony, every member of which may in its turn bud off a pile of medusa-disks."

The bodies thus detached have all the characteristics of the fully-developed medusæ. Each consists of an umbrella-shaped disk divided along its margin into lobes, generally eight in number, and of a stomach terminating in a probosciform mouth. As the creature grows, the spaces between the marginal lobes fill up; from its border long tentacles are developed, and a fringe of tendril-like filaments sprout forth from the margin. The young medusa eats voraciously, and grows proportionately large; the *Chrysaora*, which we have been describing, attaining a diameter of fifteen inches, and the *Rhizostoma* sometimes reaching to three feet. These medusæ are familiarly known as *sea-nettles*. When they have reached full development the generative organs appear in four chambers arranged round the stomach, and are contained in curious fluted membranous ribbons which hold the sperm-cells in the male, and ova in the female. The fertilized embryos repeat the same wonderful cycle just described, developing into a hydroid from which medusa-disks are budded off.

The relation which late investigations have established between the stationary hydroids, and the medusæ, forms one of the most interesting cases, yet known, of the curious phenomenon called alternate generation. In the majority of cases we find a non-sexual, plant-like form interposed between the ovum and the directly or indirectly sexual form of medusa, though this is not always the case, as direct development has been observed from ovum to medusa.

The nearest approach, in the adult form, to special organs are the digestive cavity, and the cnidæ. The stomach, however, possesses no true parietal walls, and in one form—the fresh-water hydra—the stomach will do duty for the skin, and the skin for the stomach, if necessary; they seem to be able to live very comfortably, and digest their food without difficulty when turned wrong-side outward.

The cnidæ are barbed filaments inclosed in tiny sacs, which they can shoot out at will, for their own protection, or for the capture of their prey, as the case may be. In the hydra the sac is ejected, and a central dart is projected into the body attacked. There must be a minute poison-sac in communication with the darts, as it is found that any soft-bodied victim, released from the clasp of the tentacles, is invariably dead, no matter how short the time of its imprisonment may have been. The effects of the cnidæ in the medusæ are very well known, and have gained for them their popular name of sea-nettles. Many an unlucky swimmer has found himself wrapped in the long thread-like filaments of these transparent, floating bells, and been almost maddened as he found himself inextricably inclosed in what

seemed an invisible sheet of living fire. A tentacle of the hydroid, when carefully pressed between two glass slides, or in a compressorium, may be seen, under the microscope, to dart out thousands of these little barbed arrows.

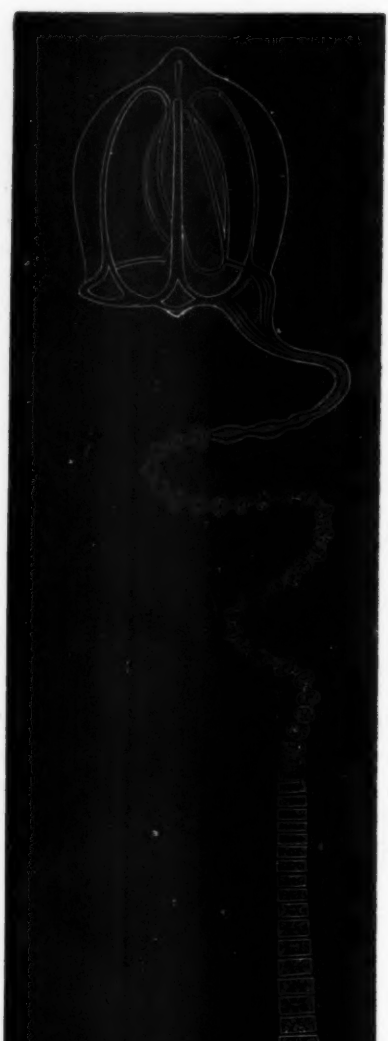

FIG. 11.—MEDUSA OF COROMORPHA NUTANS. (Magnified.)

Chronologically, the *Hydræ* (Fig. 12) come first in the group *Hydroidæ*, for they were first carefully studied and truly classified by Trembley. His observations, though made in the earlier half of the eighteenth century, were so accurate, and his delineations so correct,

that he is still quoted in the latest works as authority. The hydra is found generally in fresh water, though some few species have been discovered, in this country, in that which is somewhat brackish. It loves still or slowly-running water, and attaches itself generally to the under-side of the leaves or to the stalks of aquatic plants. Its body is extremely contractile, and consists, like the oceanic hydroids,

FIG. 12.—HYDRA VULGARIS. (Natural Size.)

in its earliest stage of development, of a simple elongated sac, with an opening which answers the purpose of a mouth. Around the mouth are a series of hollow filaments which it can entirely withdraw, and it then looks like a minute tubercle. The tentacles are roughened by the clusters of thread-cells, or cnidæ, already described. The threads have been observed in some instances to be, when extended, as much as eight inches long, and are shot out, it is thought, by the propulsive power of a liquid injected into the central cavity. It grows erect, horizontal, or inverted, as the case may be, and lives only upon animal food. The little creatures are extremely voracious and not over-nice. Trembley observed two hydras attack, at the

same time, the opposite extremities of a worm. Each having swallowed its respective half of the worm, he watched to see the result. The worm would not yield to the force of circumstances; and break, and the problem looked a difficult one of solution. The larger hydra, however, proved itself superior to circumstances, it quietly swallowed worm, antagonist, and all; and, after having sucked out the worm, disgorged his dinnerless foe!

Trembley tried the experiment, already alluded to, of turning one inside out, and fastening it in that position. The domestic economy did not appear to be at all disturbed; the little creature eating with as much relish, and digesting with as much ease, to all appearance, as in its normal position. He inserted one hydra within the cavity of another, and fastened them with a bristle which was run through both. Returning after a short absence he found them strung, side by side, upon the bristle. He repeated the experiment and watched the manœuvres of the two. The hydra inside managed to work its way through the small aperture made in the side of its neighbor by the bristle, and soon occupied the position he had before observed, side by side with its companion on the bristle. He then turned one of them inside out, inserted it in that position, and fastened them securely together. Soon the pair, finding that there was no help for it, philosophically yielded, and united their fortunes; the inner one of the couple providing nourishment for them both. They seemed to live quite comfortably, on these very close terms of intimacy, for some time.

Hydras generate in summer by buds, which grow to maturity and are then sloughed off. These young buds often produce others before they separate from the parent stem, and they others again; so that there are sometimes twenty generations produced in a month's time. In autumn oviform gemmules are extruded, lie quiescent till spring, and are then developed. Any number of artificial sections may be made, and from each a perfect animal will be developed. Wherever a wound or cut has been made, buds sprout more quickly than from the sound tissue, and the hydras generated by artificial sections are more prolific than those generated in the ordinary way. The sprouting, as may be seen in the plate (Fig. 12), takes place from any portion of the body. The leaves, flowers, and stems, of this specimen of *Hydra vulgaris*, together form the hydrasoma. This specimen was selected more to illustrate the plant-like character of the organism than for its intrinsic beauty.

The geographical distribution of the *Hydroidæ* has not yet been determined; but, like other low forms of life, we find them spreading over vast areas of space, and extending back through uncounted ages of time. We have already spoken of their distribution in depth. A well-defined specimen was taken up in the deepest cast recorded by Wyville Thomson, in his "Depths of the Sea"—that made in the Bay

of Biscay, and to a depth of nearly three miles. But, though their existence is proved at these enormous depths, they love best the rock-bound pools left by the retiring tide and the shallow water which fringes our islands and continents; and there they probably attain their greatest beauty and most perfect development.

Their distribution in time reaches back to the earliest dawnings of life upon our globe. The *Graptolites* of the Lower and Upper Silurian, the *Hydroid Medusæ* of the Jurassic, the *Hydractinea* of the Cretaceous, Miocene, and Pliocene, the *Serturella* of the Pleistocene, and the numberless forms of the present day, are the representatives of this family in geologic and historic time.

Like other humble forms of life, it shows a marvelous persistency. It has lived, almost unchanged, while great dynasties of higher organisms have one after the other risen, developed, and perished, or left only a few meagre representatives among the fauna of the present day. The fragility of their chitinous envelope and the perishable nature of their protoplasmic flesh would, of course, render it impossible that any full record of their existence should ever be found in the rocks of the primeval would, but the fragments which have, here and there, left their impress on the various geologic strata, show them to have been the contemporaries of the oldest forms of life which inhabited the Silurian seas, and to have quietly existed in the depths of those ancient waters over which the great fish and saurian dynasties lorded it through so many centuries.

ORIGIN AND DEVELOPMENT OF ENGINEERING.[1]

By Sir JOHN HAWKSHAW, F. R. S.

TO those on whom the British Association confers the honor of presiding over its meetings the choice of a subject presents some difficulty. The presidents of sections give accounts of what is new in their departments; and essays on science in general, though desirable in the earlier years of the Association, would be less appropriate to-day. Past presidents have discoursed on many subjects, on the mind and on things beyond the reach of mind, and I have arrived at the conclusion that humbler themes will not be out of place on this occasion. I propose to say something of a profession to which my life has been devoted—a theme which cannot stand as high in your estimation as in my own, but which I have chosen because I ought to understand it better than any other. I propose to say something on its origin, its work, and kindred topics.

[1] *Times's* summary of Inaugural Address at the Bristol Meeting of the British Association.

Rapid as has been the growth of the art of the engineer during the last century, we must, if we would trace its origin, seek among the earliest evidences of civilization. When settled communities were few and isolated, opportunities for the interchange of knowledge were scanty or wanting. The slowly accumulated results of the experience of a community were lost on its downfall. Inventions were lost and found again. The art of casting bronze over iron was known to the Assyrians, though it has only lately been introduced into modern metallurgy; and patents were granted in 1609 for processes connected with the manufacture of glass, which had been practised centuries before. An inventor in the reign of Tiberius devised a method of producing flexible glass, but the manufactory of the artist was totally destroyed in order to prevent the manufacture of copper, silver, and gold, from becoming depreciated.

In the long discussion which was held as to the practicability of making the Suez Canal, an early objection was brought against it that there was a difference of thirty-two and one-half feet between the level of the Red Sea and that of the Mediterranean. Laplace declared that such could not be the case, for the mean level of the sea was the same on all parts of the globe. Centuries before the time of Laplace the same objection had been raised against a project for joining the waters of these two seas. According to the old Greek and Roman historians, it was a fear of flooding Egypt with the waters of the Red Sea that made Darius, and in later times again Ptolemy, hesitate to open the canal between Suez and the Nile. Yet this canal was made and was in use some centuries before the time of Darius. Strabo tells us that the same objection, that the adjoining seas were of different levels, was made by his engineers to Demetrius, who wished to cut a canal through the Isthmus of Corinth some two thousand years ago. But Strabo dismisses at once this idea of a difference of level, agreeing with Archimedes that the force of gravity spreads the sea equally over the earth.

When knowledge in its higher branches was confined to a few, those who possessed it were called upon to perform various services for the communities to which they belonged; and we find mathematicians, and astronomers, painters, sculptors, and priests, called upon to perform the duties which now pertain to the profession of the architect and the engineer. As soon as civilization had advanced so far as to admit of the accumulation of wealth and power, then kings and rulers sought to add to their glory while living by the erection of magnificent dwelling-places, and to provide for their aggrandizement after death by the construction of costly tombs and temples.

The earliest buildings of stone to which we can assign a date, with any approach to accuracy, are the pyramids of Ghizeh. The genius for dealing with large masses in building did not pass away with the pyramid-builders in Egypt, but their descendants continued to gain in

mechanical knowledge. The Romans, though they did not commonly use such large stones in their own constructions, carried off the largest obelisks from Egypt and erected them at Rome, where more are now to be found than remain in Egypt.

It has sometimes been questioned whether the Egyptians had a knowledge of steel. It seems unreasonable to deny them this knowledge. Iron was known at the earliest times of which we have any record. It is often mentioned in the Bible, and in Homer; it is shown in the early paintings on the walls of the tombs at Thebes; it has been found in quantity in the ruined palaces of Assyria; and in the inscriptions of that country fetters are spoken of as having been made of iron, which is also so mentioned in connection with other metals as to lead to the supposition that it was regarded as a base and common metal. The quality of iron which is now made by the native races of Africa and India is that which is known as wrought-iron. Dr. Percy says the extraction of good malleable iron, directly from the ore, "requires a degree of skill very far inferior to that which is implied in the manufacture of bronze." The supply of iron in India as early as the fourth and fifth centuries seems to have been unlimited. In the temples of Orissa iron was used in large masses as beams or girders in roof-work in the thirteenth century, and India well repaid any advantage which she may have derived from the early civilized communities of the West if she were the first to supply them with iron and steel. If we look still farther to the East, China had probably knowledge of the use of metals as soon as India, and, moreover, had a boundless store of iron and coal. A great future is undoubtedly in store for that country; but can the race who now dwell there develop its resources, or must they await the aid of an Aryan race? The art of extracting metals from the ore was practised at a very early date in this country. The Romans worked iron extensively in the Weald of Kent, as we assume from the large heaps of slag containing Roman coins which still remain there. Coal, which was used for ordinary purposes in England as early as the ninth century, does not appear to have been largely used for iron-smelting until the eighteenth century, though a patent was granted for smelting iron with coal in the year 1611. The use of charcoal for that purpose was not given up until the beginning of this century, since which period an enormous increase in the mining and metallurgical industries has taken place; the quantity of coal raised in the United Kingdom in 1873 having amounted to 127,000,000 tons, and the quantity of pig-iron to upward of 6,500,000 tons.

The early building energy of the world was chiefly spent on the erection of tombs, temples, and palaces. While in Egypt, as we have seen, the art of building in stone had 5,000 years ago reached the greatest perfection, so in Mesopotamia the art of building with brick, the only available material in that country, was in an equally ad-

vanced state some ten centuries later. The practice of building great pyramidal temples seems to have passed eastward to India and Burmah, where it appears in buildings of a later date, in Buddhist topes and pagodas; marvels of skill in masonry, and far surpassing the old brick mounds of Chaldea in richness of design and in workmanship. Egypt was probably far better irrigated in the days of the Pharaohs than it is now; and Lake Mœris, of which the remains have been explored by M. Linant, was a reservoir made by one of the Pharaohs, and supplied by the flood-waters of the Nile. It was 150 square miles in extent, and was retained by a bank or dam 60 yards wide and 10 high, which can be traced for a distance of 13 miles. This reservoir was capable of irrigating 1,200 square miles of country. No work of this class has been undertaken on so vast a scale since, even in these days of great works. The springs of knowledge which had flowed so long in Babylonia and Assyria were dried up at an early period; but Egypt remained the fountain-head whence knowledge flowed to Greece and Rome. The early constructive works of Greece, till about the seventh century B. C., form a strong contrast to those of its more prosperous days. Commonly called Pelasgian, they are more remarkable as engineering works than admirable as those which followed them were for architectural beauty. Walls of huge unshapely stones — admirably fitted together, however — tunnels, and bridges characterize this period. In Greece, during the few and glorious centuries which followed, the one aim in all construction was to please the eye, to gratify the sense of beauty; and in no age was that aim more thoroughly and satisfactorily attained.

In these days, when sanitary questions attract each year more attention, we may call to mind that twenty-three centuries ago the city of Agrigentum possessed a system of sewers, which on account of their large size was thought worthy of mention by Diodorus. This is not, however, the first record of towns being drained. The well-known Cloaca Maxima, which formed part of the drainage system of Rome, was built some two centuries earlier, and great vaulted drains passed beneath the palace-mounds of unburnt brick at Nimroud and Babylon, and possibly we owe the preservation of many of the interesting remains found in the brick-mounds of Chaldea to the very elaborate system of pipe drainage discovered in them and described by Loftus. While Pelasgian art was being superseded in Greece, the city of Rome was founded, in the eighth century before our era; and Etruscan art in Italy, like the Pelasgian art in Greece, was slowly merged in that of an Aryan race.

It would be impossible for me to do justice to even a small part of the engineering works which remain to this day as monuments of the skill, the energy, and ability, of the great Roman people. War, with all its attendant evils, has often indirectly benefited mankind. In the sieges which took place during the wars of Greece and Rome, the in-

ventive power of man was taxed to the utmost to provide machines for attack and defense. The ablest mathematicians and philosophers were pressed into the service, and helped to turn the scale in favor of their employers. The world has to regret the loss of more than one who, like Archimedes, fell slain by the soldiery while applying the best scientific knowledge of the day to devising means of defense during the siege. The necessity for roads and bridges for military purposes has led to their being made where the stimulus from other causes was wanting; and means of communication and the interchange of commodities, so essential to the prosperity of any community, have thus been provided. Such was the case under the Roman Empire. So, too, in later times, the ambition of Napoleon covered France and the countries subject to her with an admirable system of military roads. So, again, in this country, it was the rebellion of 1745, and the want felt of roads for military purposes, which first led to the construction of a system of roads in it unequaled since the time of the Roman occupation. And lastly, in India, in Germany, and in Russia, more than one example could be pointed out where industry will be benefited by railways which have originated in military precautions rather than in commercial requirements.

But to return to Rome. Roads followed the tracks of her legions into the most distant provinces of the empire. Three hundred and seventy-two great roads are enumerated, together more than 48,000 miles in length, according to the itinerary of Antoninus. The water-supply of Rome during the first century of our era would suffice for a population of 7,000,000, supplied at the rate at which the present population of London is supplied. This water was conveyed to Rome by nine aqueducts; and in later years the supply was increased by the construction of five more aqueducts. Three of the old aqueducts have sufficed to supply the wants of the city in modern times. These aqueducts of Rome are to be numbered among her grandest engineering works. Time will not admit of my saying any thing about her harbor works and bridges, her basilicas and baths, and numerous other works in Europe, in Asia, and in Africa.

In the fourth and succeeding centuries the barbarian hordes of Western Asia, people who felt no want of roads and bridges, swept over Europe to plunder and destroy. With the seventh century began the rise of the Mohammedan power, and a partial return to conditions apparently more favorable to the progress of industrial art, when wide-spread lands were again united under the sway of powerful rulers. Still, few useful works remain to mark the supremacy of the Mohammedan power at all comparable to those of the age which preceded its rise.

A great building-age began in Europe in the tenth century, and lasted through the thirteenth. While the building of cathedrals progressed on all sides in Europe, works of a utilitarian character, which

concern the engineer, did not receive such encouragement, excepting perhaps in Italy. In India, under the Moguls, irrigation works, for which they had a natural aptitude, were carried on during these centuries with vigor, and more than one emperor is noted for the numerous great works of this nature which he carried out.

It is frequently easier to lead water where it is wanted than to check its irruption into places where its presence is an evil, often a disaster. For centuries the existence of a large part of Holland has been dependent on the skill of man. How soon he began in that country to contest with the sea the possession of the land we do not know, but early in the twelfth century dikes were constructed to keep back the ocean. To the practical knowledge acquired by the Dutch, whose method of carrying out hydraulic works is original and of native growth, much of the knowledge of the present day in embanking, and draining, and canal-making, is due. While the Dutch were acquiring practical knowledge in dealing with water, and we in Britain, among others, were benefiting by their experience, the disastrous results which ensued from the inundations caused by the Italian rivers of the Alps gave a new importance to the science of hydraulics. Some of the greatest philosophers of the seventeenth century—among them Torricelli, a pupil of Galileo—were called upon to advise and to superintend engineering works; nor did they confine themselves to the construction of preventive works, but thoroughly investigated the condition pertaining to fluids at rest or in motion, and gave to the world a valuable series of works on hydraulics and hydraulic engineering, which form the basis of our knowledge of these subjects at the present day.

The impulse given to road-making in the early part of the last century soon extended to canals, and means for facilitating locomotion and transport generally. Tramways were used in connection with mines at least as early as the middle of the seventeenth century, but the rails were, in those days, of wood. The first iron rails are said to have been laid in this country as early as 1738, after which time their use was gradually extended, until it became general in mining districts. By the beginning of this century the great ports of England were connected by a system of canals; and new harbor-works became necessary, and were provided to accommodate the increase of commerce and trade, which improved means of internal transport had rendered possible. But it was not until the steam-engine, improved and almost created by the illustrious Watt, became such a potent instrument, that engineering works to the extent they have since been carried out became possible or necessary. But, while Watt had gained a world-wide, well-earned fame, the names of those men who have provided the machines to utilize the energies of the steam-engine are too often forgotten. Of their inventions the majority of mankind know little. They worked silently at home, in the mill, or in the factory, observed by few. Indeed, in most cases these silent workers had no wish to

expose their work to public gaze. How long in the silent night the inventors of these machines sat and pondered; how often they had to cast aside some long-sought mechanical movement and seek another and better arrangement of parts, none but themselves could ever know. They were unseen workers, who succeeded by rare genius, long patience, and indomitable perseverance.

More ingenuity and creative mechanical genius is perhaps displayed in machines used for the manufacture of textile fabrics than by those used in any other industry. It was not until late in historical times that the manufacture of such fabrics became established on a large scale in Europe. Linen was worn by the old Egyptians, and some of their linen mummy-cloths surpass in fineness any linen fabrics made in later days. The Babylonians wore linen also and wool, and obtained a wide-spread fame for skill in workmanship and beauty in design. In this country wool long formed the staple for clothing. Silk was the first rival, but its costliness placed it beyond the reach of the many. To introduce a new material or improved machine into this or other countries a century or more ago was no light undertaking. Inventors and would-be benefactors alike ran the risk of loss of life. Loud was the outcry made in the early part of the eighteenth century against the introduction of Indian cottons and Dutch calicoes. Until 1738, in which year the improvements in spinning-machinery were begun, each thread of worsted or cotton-wool had been spun between the fingers, in this and all other countries. Wyatt, in 1738, invented spinning by rollers instead of fingers, and his invention was further improved by Arkwright. In 1770 Hargreaves invented the spinning-jenny, and Crompton the mule in 1775, a machine which combined the advantages of the frames of both Hargreaves and Arkwright. In less than a century after the first invention by Wyatt, double mules were working in Manchester with over 2,000 spindles. Improvements in machines for weaving were begun at an earlier date. In 1579 a ribbon-loom is said to have been invented at Dantzic, by which from four to six pieces could be woven at one time, but the machine was destroyed and the inventor lost his life. In 1800 Jacquard's most ingenious invention was brought into use, which, by a simple mechanical operation, determines the movements of the threads which form the pattern in weaving. But the greatest improvement in the art of weaving was wrought by Cartwright's discovery of the power-loom, which led eventually to the substitution of steam for manual labor, and enabled a boy with a steam-loom to do fifteen times the work of a man with a hand-loom. For complex ingenuity few machines will compare with those used in the manufacture of lace and bobbin net. Hammond, in 1768, attempted to adapt the stocking-frame to this manufacture, which had hitherto been conducted by hand. It remained for John Heathcoat to complete the adaptation in 1809, and to revolutionize this branch of industry, reducing the cost of its produce

to one-fortieth of what the cost had been before Heathcoat's improvements were effected. Time would fail me if I were to attempt to enumerate one tithe of these rare combinations of mechanical skill; and, indeed, no one will ever appreciate the labor and supreme mental effort required for their construction who has not himself seen them and their wondrous achievements.

Steamboats, the electric telegraph, and railways, are more within the cognizance of the world at large, and the progress that has been made in them in little more than one generation is better known and appreciated. It is not more than forty years since one of our scientific men, and an able one too, declared at a meeting of this Association that no steamboat would ever cross the Atlantic; founding his statement on the impracticability, in his view, of a steamboat carrying sufficient coal, profitably, I presume, for the voyage. Like most important inventions, that of the steamboat was a long time in assuming a form capable of being profitably utilized, and, even when it had assumed such a form, the objections of commercial and scientific men had still to be overcome. The increase in the number of steamboats since the time when the Sirius first crossed the Atlantic has been very great. Whereas in 1814 the United Kingdom only possessed two steam-vessels, of together 456 tons burden, in 1872 there were on the register of the United Kingdom 3,662 steam-vessels, of which the registered tonnage amounted to over a million and a half of tons, or to nearly half the whole steam tonnage of the world, which did not at that time greatly exceed three million tons. As the number of steamboats has largely increased, so also gradually had their size increased until it culminated in the hands of Brunel in the Great Eastern. A triumph of engineering skill in ship-building, the Great Eastern has not been commercially so successful. In this, as in many other engineering problems, the question is not how large a thing can be made, but how large, having regard to other circumstances, it is proper at the time to make it.

A distinguished member of this Association, Mr. Froude, has now for some years devoted himself to investigations carried on with a view to ascertain the form of vessel which will offer the least resistance to the water through which it must pass. So many of us in these days are called upon to make journeys by sea as well as by land that we can well appreciate the value of Mr. Froude's labors, so far as they tend to curtail the time which we must spend on our ocean-journeys; and we should all feel grateful to him if from another branch of his investigations, which relates to the rolling of ships, it would result that the movement in passenger-vessels could be reduced.

There is no more remarkable instance of the rapid utilization of what was at first regarded as a mere scientific idea than the adoption and extension of the electric telegraph. Those who read Odier's letter written in 1773, in which he made known his idea of a telegraph which

would enable the inhabitants of Europe to converse with the Great Mogul little thought that in less than a century a conversation between persons at points so far distant would be possible. Still less did those, who saw in the following year messages sent from one room to another by Lesage in the presence of Frederick of Prussia, realize that they had before them the germ of one of the most extraordinary inventions among the many that will render this century famous. I should weary you were I to follow the slow steps by which the electric telegraph of to-day was brought to its present state of efficiency; but yet within how short a period of time has all the wonderful progress been achieved! How incredulous the world a few years ago would have been if then told of the marvels which in so short a space of time were to be accomplished by its agency! It is not long ago—1823—that Mr. (now Sir Francis) Ronald, one of the early pioneers in this field of science, published a description of an electric telegraph. He communicated his views to Lord Melville, and that nobleman was obliging enough to reply that the subject should be inquired into; but before the nature of Sir Francis Ronald's suggestions could be known, except to a few, that gentleman received a reply from Mr. Barrow that "telegraphs of any kind were then wholly unnecessary, and that no other than the one then in use would be adopted;" the one then in use being the old semaphore, which, crowning the tops of hills between London and Portsmouth, seemed perfection to the Admiralty of that day. The telegraphic system of the world comprises almost a complete girdle round the earth; and it is probable that the missing link will be supplied by a cable between San Francisco, in California, and Yokohama, in Japan. How resolute and courageous those who engaged in submarine telegraphy have been will appear from the fact that, though we have now 50,000 miles of cable in use, to get at this result nearly 70,000 miles were constructed and laid.

Of railways the progress has been enormous; but I do not know that in a scientific point of view a railway is so marvelous in its character as the electric telegraph. The results, however, of the construction and use of railways are more extensive and wide spread, and their utility and convenience brought home to a larger portion of mankind. The British Association is peripatetic, and without railways its meetings, if held at all, would, I fear, be greatly reduced in numbers. Moreover, you have all an interest in them; you all demand to be carried safely, and you insist on being carried fast. I shall not enter on a history of the struggles which preceded the opening of the first railway. They were brought to a successful issue by the determination of a few able and far-seeing men. The names of Thomas Gray and Joseph Sandars, of William James and Edward Pease, should always be remembered in connection with the early history of railways, for it was they who first made the nation familiar with the idea. There is no fear that the name of Stephenson will be forgotten, whose prac-

tical genius made the realization of the idea possible. Railways add enormously to the national wealth. More than twenty-five years ago it was proved, to the satisfaction of a committee of the House of Commons, that the Lancashire & Yorkshire Railway effected a saving to the public using the railway of more than the whole amount of the dividend which was received by the proprietors. These calculations were based solely on the amount of traffic carried by the railway and on the difference between the railway rate of charge and the charges by the modes of conveyance anterior to railways. No credit whatever was taken for the saving of time, though in England preëminently time is money. Considering that railway charges on many items have been considerably reduced since that day, it may be safely assumed that the railways in the British Islands now produce, or rather save to the nation, a much larger sum annually than the gross amount of all the dividends payable to the proprietors, without at all taking into account the benefit arising from the saving in time. The benefits under that head defy calculation, and cannot with any accuracy be put into money; but it would not be at all over-estimating this question to say that in time and money the nation gains at least what is equivalent to ten per cent. on all the capital expended on railways. It follows that, whenever a railway can be made at a cost to yield the ordinary interest of money, it is in the national interest that it should be made. Further, that, though its cost might be such as to leave a smaller dividend than that to its proprietors, the loss of wealth to so small a section of the community will be more than supplemented by the national gain, and therefore there may be cases where a government may wisely contribute in some form to undertakings which, without such aid, would fail to obtain the necessary support. And so some countries—Russia, for instance—to which improved means of transport are of vital importance, have wisely, in my opinion, caused lines to be made which, having regard to their own expenditure and receipts, would be unprofitable works, but in a national point of view are or speedily will be highly advantageous.

A question more important probably in the eyes of many—safety of railway-traveling—may not be inappropriate. At all events, it is well that the elements on which it depends should be clearly understood. It will be thought that longer experience in the management of railways should go to insure greater safety, but there are other elements of the question which go to counteract this in some degree. The safety of railway-traveling depends on the perfection of the machine in all its parts, including the whole railway, with its movable plant, in that term; it depends also on the nature and quantity of traffic; and, lastly, on human care and attention. With regard to what is human, it may be said that so many of these accidents as arise from the fallibility of men will never be eliminated until the race be improved. The liability to accident will also increase with the speed,

and might be reduced by slackening that speed. It increases with the extent and variety of the traffic on the same line. The public, I fear, will rather run the risk than consent to be carried at a slower rate. The increase in extent and variety of traffic is not likely to receive any diminution; on the contrary, it is certain to augment. I should be sorry to say that human care may not do something, and I am not among those who object to appeals through the press and otherwise to railway companies, though sometimes perhaps they may appear in an unreasonable form. I see no harm in men being urged in every way to do their utmost in a matter so vital to many. It is practicable, by certain corrections of the official returns, to make some sort of comparison between the accidents in the earlier days of our own railways and the accidents occurring at a later date. I have endeavored to make these corrections, and I believe the results arrived at may be taken as fairly accurate. From the figures it appears that the passenger mileage has doubled between 1861 and 1873; and at the rate of increase between 1870 and 1873 it would become double what it was in 1873 in twelve years from that time—namely, in 1885. The number of passengers has doubled between 1864 and 1873, and at the rate of increase between 1870 and 1873 it would become double what it was in 1873 in eleven and a half years, or in 1885. Supposing no improvement had been effected in the working of railway-traffic, the increase of accidents should have borne some proportion to the passenger mileage, multiplied by the proportion between the train mileage and the length of line open, as the number of trains passing over the same line of rails would tend to multiply accidents in an increasing proportion, especially where the trains run at different speeds. The number of accidents varies considerably from year to year, but, taking two averages of ten years each, it appears that the proportion of deaths of passengers from causes beyond their control to passenger miles traveled in the ten years ending December 31, 1873, was only two-thirds of the same proportion in the ten years ending December 31, 1861. The limit of improvements will probably be reached before long, and the increase of accidents will depend on the increase of traffic, together with the increased frequency of trains. Up to the present time the improvements appear to have kept pace with the increase of traffic and of speed, as the slight increase in the proportion of railway accidents to passenger miles is probably chiefly due to a larger number of trifling bruises being reported now than formerly. I believe it was a former president of the Board of Trade who said to an alarmed deputation, who waited upon him on the subject of railway traveling, that he thought he was safer in a railway-carriage than anywhere else. If he gave any such opinion, he was not far wrong, as is sufficiently evident when it can be said that there is only one passenger injured in every four million miles traveled, or that, on an average, a person may travel 100,000 miles each year for forty years,

and the chances be slightly in his favor of his not receiving the slightest injury.

A pressing subject of the present time is the economy of fuel. Members of the British Association have not neglected this momentous question. Many cases of waste arise from the existence of old and obsolete machines, of bad forms of furnaces, of wasteful grates, existing in most dwelling-houses; and these are not to be remedied at once, for not every one can afford, however desirable it might be, to cast away the old and adopt the new. In looking uneasily to the future supply and cost of fuel, it is, however, something to know what may be done even with the application of our present knowledge; and, could we apply it universally to-day, all that is necessary for trade and comfort could probably be as well provided for by one-half the present consumption of fuel; and it behooves those who are beginning to build new mills, new furnaces, new steamboats, or new houses, to act as though the price of coal which obtained two years ago had been the normal and not the abnormal price.

There was in early years a battle of the gauges, and there is now a contest about guns; but your time will not permit me to say much on their manufacture. Here, again, the progress made in a few years has been enormous, and in contributing to it, two men—Sir William Armstrong and Sir Joseph Whitworth, both civil engineers—in this country, at all events, deservedly stand foremost. Docks and harbors I have no time to mention, for it is time this long and, I fear, tedious address should close.

"Whence and whither" is the aphorism which leads us away from present and plainer objects to those which are more distant and obscure; whether we look backward or forward our vision is speedily arrested by an impenetrable veil. On the subject I have chosen you will probably think I have traveled backward far enough. I have dealt to some extent with the present. The retrospect, however, may be useful to show what great works were done in former ages. Some things have been better done than in those earlier times, but not all. In what we choose to call the ideal we do not surpass the ancients. Poets and painters and sculptors were as great in former times as now; so, probably, were the mathematicians. In what depends on the accumulation of experience we ought to excel our forerunners. Engineering depends largely on experience; nevertheless, in future times whenever difficulties shall arise, or works have to be accomplished for which there is no precedent, he who has to perform the duty may step forth from any of the walks of life, as engineers have not unfrequently hitherto done. The marvelous progress of the last two generations should make every one cautious of predicting the future. Of engineering works it may be said that their practicability or impracticability is often determined by other elements than the inherent difficulty in the works themselves. Greater works than any yet achieved remain to be

accomplished—not, perhaps, yet awhile. Society may not yet require them; the world could not at present afford to pay for them. The progress of engineering works, if we consider it, and the expenditure upon them, has already in our time been prodigious. One hundred and sixty thousand miles of railway alone, put into figures at £20,000 a mile, amounts to £3,200,000,000 sterling; add 400,000 miles of telegraph at £100 a mile, and £100,000,000 more for sea-canals, docks, harbors, water and sanitary works constructed in the same period, and we get the enormous sum of £3,340,000,000 sterling expended in one generation and a half on what may undoubtedly be called useful works. The wealth of nations may be impaired by expenditure on luxuries and war; it cannot be diminished by expenditure on works like these.

As to the future, we know we cannot create a force; we can, and no doubt shall, greatly improve the application of those with which we are acquainted. What we called inventions can do no more than this, yet how much every day is being done by new machines and instruments! The telescope extended our vision to distant worlds. The spectroscope has far outstripped that instrument, by extending our powers of analysis to regions as remote. Postal deliveries were and are great and able organizations, but what are they to the telegraph? Need we try to extend our vision into futurity farther? Our present knowledge, compared with what is unknown even in physics, is infinitesimal. We may never discover a new force—yet, who can tell?

INSECTIVOROUS PLANTS.

By E. R. LELAND.

MOST amateur botanists have in the course of their walks come upon the peculiar leaves of the common sundew (*Drosera rotundifolia*), with the clear drops which the leaves bear glistening in the morning sun, and, on referring to their manuals, have noted the relationship which it bears to Venus's fly-trap (*Dionæa muscipula*), whose famous irritability is always a matter for mention.

In collecting the showy side-saddle-flower (*Sarracenia purpurea*), they have, of course, observed that its curious, trumpet-shaped leaves are usually half-filled with water and drowned insects.

In fishing from the stagnant pools, the inconspicuous, yellow blossoms, and rootless capillary leaves of the bladderwort (*Utricularia vulgaris*), they have doubtless noticed how they swarmed with insects and small crustaceans; and have accepted, with that unhesitating faith which our whole system of education begets and fosters, the statement that the little bladders are filled with air, and that their function is to float the plant at the time of flowering.

Possibly they may have noticed that the sticky leaves of the butterwort (*Pinguicula vulgaris*) are sometimes strongly incurved.

If, observing these matters, they have given them but a passing thought; have failed to see the relation, or apprehend the motives of the phenomena; and are surprised some day by learning that they point to one of the most wonderful discoveries of modern biology—they need reproach themselves with no exceptional heedlessness or obtuseness, for they have the illustrious company of most of the famous botanists from Linnæus down to those of the present generation.

Some attention has recently been called to the carnivorous habits of what Dr. Hooker calls "our brother-organisms—plants," by the appearance in different scientific periodicals of some brief note, or paper, by occasional observers; and more generally by Prof. Gray's papers which appeared in the *Nation*, April, 1874, pp. 216, 232, in which he announced some of the facts that had been communicated by Mr. Darwin and others. Some of these statements must, it should be said, be modified in the light of later observations.

It has turned out, as so often it does, that some of the more obvious observations and conclusions were made and drawn long ago, and recorded only to be overlooked and forgotten. The subject has a history running back a century or more. It is of more than common interest, and has been well told by Dr. Joseph Hooker, in his address to the department of Zoölogy and Botany, British Association, Belfast, August, 1874. Much condensed, it is as follows:

Dionæa.—About 1768, Ellis, a well-known English naturalist, sent to Linnæus a drawing of a plant, to which he gave the poetical name of *Dionæa*. "The plant," wrote Ellis, "shows that Nature may have some views toward its nourishment in forming the upper joint of its leaf like a machine to catch food; upon the middle of this lies the bait for the unhappy insect that becomes its prey. Many minute red glands that cover its surface tempt the animal to taste them; and, the instant these tender parts are irritated by its feet, the two lobes rise up, grasp it fast, lock the rows of spines together, and squeeze it to death. And further, lest the strong efforts for life in the creature, just taken, should serve to disengage it, three small spines are fixed near the middle of each lobe, among the glands, that effectually put an end to its struggles. Nor do the lobes ever open again while the dead animal continues there. It is nevertheless certain that the plant cannot distinguish an animal from a vegetable or mineral substance; for, if we introduce a straw or pin between the lobes, it will grasp it fully as fast as if it were an insect."

This account, substantially correct, but erroneous in some particulars, led Linnæus to declare that, though he had seen and examined no small number of plants, he had never met with so wonderful a phenomenon. He was, however, too sagacious to accept Ellis's account of the *coup-de-grâce* which the insects received from the three stiff

hairs in the centre of each lobe of the leaf. He was also unable to bring himself to believe that Nature intended the plant "to receive some nourishment from the animals it seizes," and he accordingly declared that, as soon as the insects ceased to struggle, the leaf opened and let them go. He only saw in these wonderful actions an extreme case of sensitiveness in the leaves; and he consequently regarded the capture of the disturbing insects as merely accidental, and of no importance to the plant.'

Linnæus's authority caused his statements to be faithfully copied from book to book.

Sixty years after Linnæus wrote, an able botanist, the Rev. Dr. M. A. Curtis (who died in 1872), lived at Wilmington, North Carolina, the headquarters of this very local plant. In 1834 he published an account of it in the *Boston Journal of Natural History*, which is a model of accurate scientific observation. He said: "Each half of the leaf is a little concave on the inner side, where there are placed three delicate, hair-like organs, in such order that an insect can hardly traverse it without interfering with one of them, when the two sides suddenly collapse, and inclose the prey, with a force surpassing an insect's efforts to escape. The fringes of hairs on the opposite sides of a leaf interlace like the fingers of two hands clasped together. The sensitiveness resides only in these hair-like processes on the inside, as the leaf may be touched or pressed in another part without sensible effects. The little prisoner is not crushed and suddenly destroyed, for I have often liberated captive flies and spiders which sped away as fast as fear or joy could carry them. At other times, I have found them enveloped in a fluid of mucilaginous consistence which seems to act as a solvent, the insects being more or less consumed in it. This circumstance has suggested the possibility of their being made subservient to the nourishment of the plant through an apparatus of absorbent vessels in the leaves."

To Ellis belongs the credit of divining the purpose of the capture of insects by the *Dionæa*. But Curtis made out the details of mechanism by ascertaining the seat of the sensitiveness of the leaves; and he also pointed out that the secretion was not a lure exuded before the capture, but a true digestive fluid poured out like our own gastric juice after the ingestion of food. (Prof. Gray quotes Dr. Curtis's observations on the *Dionæa* in his "Genera of the Plants of the United States," vol. i., p. 196, 1849, without comment; and his plate of the plant does not show any of the important sensitive spines.)

The investigation of this curious question again rested until 1868, when it was taken up by Mr. Canby, who was then staying in the *Dionæa* district. He found that the leaf had the power of dissolving animal matter, and that small pieces of beef that were fed to it were completely dissolved and absorbed; the leaf opening again with a dry surface and ready for another meal, though with an appetite somewhat

jaded. It not only could be surfeited, but it suffered from indigestion; and a meal of cheese disagreed with the leaves so seriously as finally to kill them.

Finally, Dr. Burdon-Sanderson has made an important contribution to this investigation, by demonstrating the correspondence between the electrical phenomena which accompany muscular action and those which are associated with the closing of the Dionæa-leaf. He has shown that, not alone in the electrical but in structural changes which ensue, the resemblance is complete between the contraction of muscle and that of the leaf; and, the further the inquiry is pursued, the more striking does the resemblance appear.

Drosera.—Unlike the preceding genus, which is confined to a single district, the sundews are widely distributed. The fact that they are closely related to the *Dionæa* was little known when the curious habits, which are now attracting so much attention, were first discovered.

Mr. Gardom, a Derbyshire botanist, gives an account of what his friend Mr. Whateley, an eminent London surgeon, made out in 1780: "On inspecting some of the contracted leaves we observed a small insect very closely imprisoned therein, which occasioned some astonishment as to how it happened to get into so confined a situation. Afterward, on Mr. Whateley's centrically pressing with a pin other leaves yet in their natural and unexpanded form, we observed a remarkably sudden and elastic spring of the leaves, so as to become inverted upward, and, as it were, encircling the pin, which evidently showed the method by which the fly came into its embarrassing situation."

This account, which is erroneous in representing the movement of the hairs as much more rapid than it really is, must have been written from memory.

In July of the preceding year (though the account was not published till two years afterward), Roth, in Germany, had remarked, in *Drosera rotundifolia* and *longifolia*, that "many leaves were folded together from the point toward the base, and that all the hairs were bent like a bow." Upon opening these leaves, he says: "I found in each a dead insect; hence I imagined that this plant, which has some resemblance to the *Dionæa muscipula*, might also have a similar moving power. . . . With a pair of pliers I placed an ant upon the middle of the leaf of *D. rotundifolia*. The ant endeavored to escape, but was held fast by the clammy juice at the points of the hairs, which was drawn out by its feet into fine threads. In some minutes, the short hairs on the disk of the leaf began to bend, and in some hours the end of the leaf was so bent inward as to touch the base. The ant died in fifteen minutes, which was before all the hairs had bent themselves."

These facts, established nearly a century ago, by the testimony

of independent observers, have up to the present time been almost ignored.

More recently, however, they have been repeatedly verified: in Germany, by Nitschke, in 1860; in this country by L. A. Millington, a correspondent of the *American Naturalist*, April, 1868; by Mrs. Treat, of New Jersey, *American Journal of Science*, November, 1871, and *American Naturalist*, December, 1873; by Mr. A. W. Bennett, at the meeting of the British Association for the Advancement of Science, 1873.

It is noticeable that all of these observers unite in reporting one erroneous conclusion, namely, that the movements do not result when inorganic substances are placed upon the leaves. Darwin's experiments show that although the effect is not so great and the substances are not so long detained, yet such bodies as bits of cinder do possess the power of irritation.

Mrs. Treat also reported that, when a living fly was pinned at a distance of half an inch from the leaves of the *D. filiformis*, the leaves bent toward it and reached it in an hour and twenty minutes. Mr. Darwin was not only unable to obtain any similar results, but, to admit that this motion was any thing other than an accident, would compel him to adopt some other theory than the one he now holds to account for the transmission of the impulse to motion.

Reference may here be made to a remarkable statement in a note of M. Ziegler to the Paris Academy of Sciences, in 1872. He says: "In studying these remarkable plants, I noticed that all the albuminoid animal substances, if held for a moment between the fingers, acquired the property of making the hairs of the *Drosera* contract. I also observed that such substances, when they had not been in contact with a living animal, had no visible action on the hairs. This shows that the simple contact of the fingers communicates to inert animal substances a property which they did not possess before." Repeated experiments, in which every precaution was taken by Mr. Darwin, seem effectually to negative this extraordinary belief of M. Ziegler.

This, then, is a brief review of the subject up to the recent publication of Mr. Darwin's book upon it. It has for some time been known, to all who have followed the question, that he was engaged in researches that would one day be published, and they have been waiting for them with eager interest. With characteristic patience and caution, it is only after fifteen years of careful investigation that he puts forth the results of the long series of observations. As one reads the book, the most vivid impression made is by the wonderful amount of painstaking labor that the record of the experiments shows. Like the artist of Kouroo, he seems to have said to himself: "Time is an ingredient that enters into no perfect work; and my work shall be perfect in all respects, though I should do nothing else in my life." And, lo!

while the task which he set to himself was to answer the question, "Why the *Drosera* caught such numbers of insects," the result has been the most valuable contribution to botanical literature which this age has seen. Competent critics pronounce it more important than his works on the "Fertilization of Orchids," and the "Movements and Habits of Climbing Plants;" and in scientific research there is, for Mr. Darwin, no higher standard of comparison than to compare him with himself.

The greater part of the book is given to the record of observations on the phenomena shown by *Drosera rotundifolia*. This well-known plant bears from two or three to five or six leaves, generally extended more or less horizontally, but sometimes extending vertically upward. The shape and general appearance are shown, as seen from above, in Fig. 1:

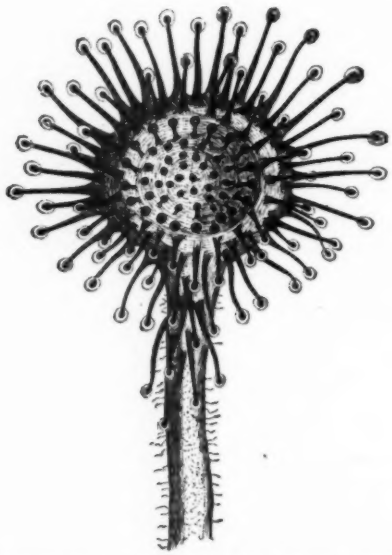

FIG. 1.—DROSERA ROTUNDIFOLIA.—Leaf viewed from above; enlarged four times.

The leaves are commonly a little broader than long; the whole upper surface being covered with gland-bearing filaments, or tentacles, as Mr. Darwin calls them, from their manner of acting.

A tentacle consists of a thin, straight, hair-like pedicel, carrying a gland on the summit. Each gland is surrounded by a large drop of extremely viscid secretion; they average about two hundred on each leaf, and as they glitter in the morning sun have given to the plant its poetical name. The tentacles on the central part of the leaf are short and stand upright, and their pedicels are green. Toward the margin they become longer and longer and more inclined outward, with their pedicels of a purple color. Those on the extreme

margin project in the same plane with the leaf, or more commonly (*see* Fig. 2) are considerably reflexed.

If a small object be placed on the glands in the centre of the leaf, a motor impulse is transmitted to the marginal tentacles. The nearer ones are first affected, and then those farther off, until at last all are slowly but unerringly inflected, and close over the object. This takes place in from one to five or more hours; the difference in time de-

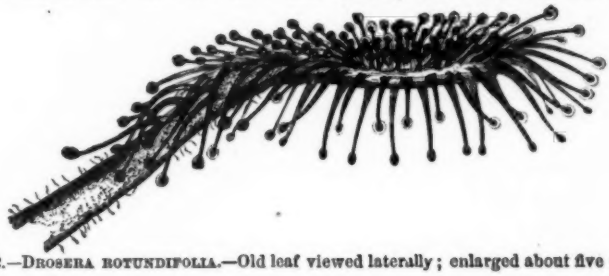

FIG. 2.—DROSERA ROTUNDIFOLIA.—Old leaf viewed laterally; enlarged about five times.

pending on several circumstances, as the size of the object and its nature; on the vigor and age of the leaf; whether it has lately been in action; and the temperature.

The tentacles in the centre do not become inflected when directly excited, though they are capable of inflection if excited by a motor impulse from other glands; but through and from them the motor impulse spreads gradually on all sides. Such is not the case with the marginal tentacles. If a bit of meat be placed on one of these it quickly transmits an impulse to its own bending portion, but never to those adjoining (*see* Fig. 5), for these are never affected until the meat has been carried to the central glands, which then radiate their conjoined impulse on all sides.

The sensitiveness of the leaves is located in the glands together with the immediately underlying cells of the tentacles. Though it is necessary that the glands should be touched, it is wonderful how slight a pressure will suffice. A bit of human hair $\frac{1}{60}$ of an inch in length and weighing only $\frac{1}{78\frac{1}{4}40}$ of a grain will induce motion, transmit a motor impulse through the whole length of a marginal tentacle, and cause it to sweep through an angle of 180° or more. This minute morsel, it must be borne in mind, rests upon and is supported by the dense, viscid fluid which surrounds the gland, and the pressure is thus rendered inconceivably slight. Mr. Darwin conjectures that it may be less than the millionth of a grain. While the pressure may be extremely slight, it needs must be steady. A sharp, sudden brush of the tentacles does not induce inflection, nor do drops of water falling upon the glands from any height. This specialized nature of the sensitiveness may readily be seen to be of great use to the plant, effecting an economy of time and energy, for the process of inflection is slow and that of reëxpansion still slower, often occupy-

ing many hours, and even days. It should be mentioned that, when excited by soluble matter of the proper kind, not only the tentacles, but the disks, are inflected and close in about the object. There is thus formed out of the leaf a stomach; a comparison that Mr. Darwin has proved to be no fanciful one. Space will not permit giving even examples of his exhaustive experiments; to the book itself must be referred those who may doubt their thoroughness, or question the conclusions drawn from them.

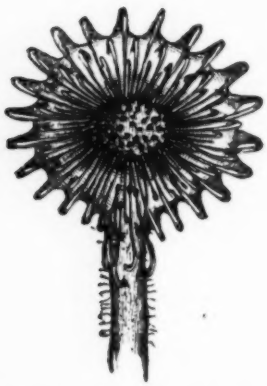

FIG. 3.—DROSERA ROTUNDIFOLIA.—Leaf (enlarged) with all the tentacles closely inflected.

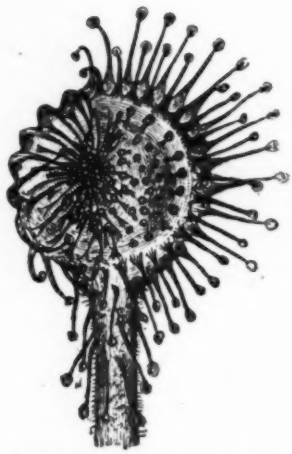

FIG. 4.—DROSERA ROTUNDIFOLIA.—Leaf (enlarged) with the tentacles on one side inflected over a bit of meat.

It is proved that the leaves are capable of true digestion, and that the glands absorb the digested matter. The correspondence between the secretion of the *Drosera* and the gastric juice of animals is shown in that which it fails to digest as well as that which it succeeds in digesting. As is well known, the gastric juice contains an acid and a ferment, both of which are requisite for digestion; so it is with the secretion of *Drosera*. When the stomach of an animal is mechanically irritated, it secretes an acid; when bits of glass are put on the glands of *Drosera*, the secretion and that of the surrounding glands are increased in quantity and become acid. The stomach of an animal, however, does not secrete its proper ferment, pepsin, until certain substances called peptogenes are absorbed; matter must be absorbed by the glands of *Drosera* before they secrete their proper ferment. Like gastric juice, the secretion of *Drosera* has antiseptic properties. Meat is dissolved by each in the same manner and by the same stages. It promptly dissolves cartilage, a substance so little affected by water. It dissolves bone, and even the enamel of teeth. In short, there is no doubt that the ferment in both cases is closely similar if not identically the same, a fact in physiology which may well be called wonderful!

When it is considered where the plant grows—generally on extremely poor, peaty soil—it is evident that the supply of nitrogen would be quite deficient unless the plant had the power of obtaining this important element from captured insects, and we can thus understand how its roots are so poorly developed. These usually consist of only two or three slightly divided branches from half to one inch in length, furnished with absorbent hairs: it appears that they serve only to imbibe water, though, of course, they will absorb nitrogenous matter when supplied.

Confirmation of these statements is furnished by some experiments, concluded since the publication of Mr. Darwin's book, by Mr. Lawson Tait, an account of which he sends to *Nature*, July 29, 1875, p. 251. Only the results can be stated, and those briefly: "It is certain that the sundew not only absorbs nutriment by its leaves, but that it can actually live and thrive by their aid alone (that is, without the aid of roots); that nitrogenous matter is more readily absorbed by the leaves than by the roots, for over-feeding kills the plant sooner by the leaves alone than by the roots alone."

Mr. Tait also announces that from the secretion of *Drosera dichiotoma* he has been able to separate a substance closely resembling pepsin.

If a tentacle receives an impulse from its own glands the movement is always toward the centre of the leaf (Fig. 5).

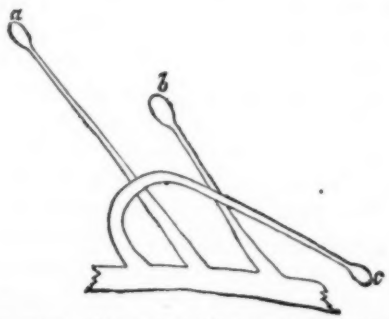

FIG. 5.—DROSERA ROTUNDIFOLIA.—Diagram showing one of the exterior tentacles closely inflected; the two adjoining ones in their ordinary position.

On the other hand, when the motor impulse comes from one side of the disk, the surrounding tentacles, including the short central ones, all bend with precision toward the point of excitement, wherever this may be seated. This is in every way a remarkable phenomenon; for the leaf falsely appears as if endowed with the senses of an animal (*see* Fig. 4).

In every case the impulse from a gland has to travel for at least a short distance to the basal part of the tentacle, the gland being carried solely by the inflection of the lower part. When the central

glands are stimulated, and the extreme marginal tentacles become inflected, the motor impulse is transmitted across half the diameter of the disk. It passes not along the vascular system, but through the cellular tissue, traveling more rapidly and easily in a longitudinal than in a transverse line, probably for the reason that the cells are elongated longitudinally, and some obstruction is encountered at each cell-wall through which the motor impulse must pass.

A molecular change of the protoplasm within the cells, to which Mr. Darwin has given the name of aggregation, precedes and accompanies all motion. When a leaf which has not been excited or inflected is examined, the cells forming the pedicels are seen to be filled with an homogeneous purple fluid. If the tentacle be examined some hours after having been excited, the purple matter is found to be aggregated into masses of various shapes suspended in a colorless fluid. The change begins within the glands and travels downward, being arrested for a short time at each cell-wall; the aggregated masses perpetually changing form, separating and uniting. After the cause of the excitement has been removed, and the tentacles have reëxpanded, the colored masses of protoplasm are redissolved, and the purple fluid again becomes homogeneous and transparent. This process of aggregation is not dependent upon the inflection of the tentacles or increased secretion of the glands—a most remarkable feature of the phenomenon being that in the tentacles which are inflected by an indirect irritation, conveyed by motor impulse from other glands, some influence is sent up to the glands, as their secretion is increased and becomes acid; then the glands thus excited send back some other action, causing the protoplasm to aggregate in cell beneath cell. There can actually be seen a molecular change proceeding, which may be somewhat similar to the molecular change which is supposed to be sent from one end of a nerve to another when sensation is felt. We have here a reflex action, and the only known case thereof in the vegetable kingdom. The rate at which the motor impulse is transmitted is much slower than in animals. This fact, as well as that of the motor impulse not being specially directed to certain points, are both, no doubt, due to the absence of nerves. Nevertheless, we perhaps see the prefigurement of the formation of nerves in animals in the transmission of the motor impulse being much more rapid down the confined space within the tentacles than elsewhere, and somewhat more rapid in a longitudinal than in a transverse direction across the disk.

Of course, there is not in this, or in the reflex action, any thing comparable with the nervous systems of animals, and, as Mr. Darwin says, "the greatest inferiority of all is the absence of a central organ, able to receive impressions from all points, to transmit their effects in any definite direction, to store them up and reproduce them." That is to say, *Drosera* seems to be without even the pre-

figurement of a brain, and we can almost fancy that we detect a trace of disappointment or regret in this admission.

A wide range of experiment shows that probably all the species of *Drosera* are adapted for catching and digesting insects by nearly the same means, though not with equal development or completeness.

Dionæa muscipula.—The form of the bilobed leaf which is the most wonderful feature of this wonderful plant, already described, may be seen from the accompanying sketch.

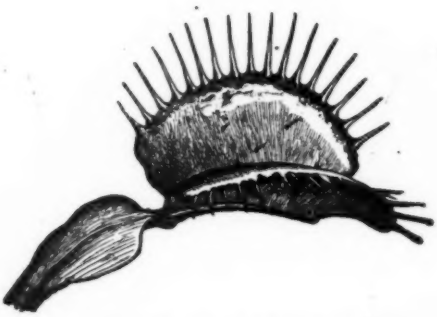

FIG. 6.—DIONÆA MUSCIPULA.—Leaf viewed laterally in its expanded state.

In the *Dionæa* the locality of sensitiveness is the three filaments which appear on each half of the upper surface of the leaf. It is unlike *Drosera* in that the filaments are sensitive to sudden impact, the transmission of the impulse is more rapid and the consequent movement instantaneous. Another point of unlikeness consists in the power of secretion of the glands, those of *Dionæa* being only excited by the absorption of nitrogenous matter. When any substance comes in contact with the filaments, the lobes of the disk close instantly upon it, confining it in a concave chamber; if the imprisoned matter be nitrogenous the lobes are gradually pressed closer together, the glands secrete freely and reëxpansion takes place only after from nine to twenty-four days, when nearly all trace of the substance will have disappeared, and sensitiveness is lost, only to reappear after some time has elapsed, if at all. If, however, the closing is the result of sudden impact or of the contact of a non-nitrogenous substance, the leaf shortly opens again and is at once sensitive, the glands showing no signs of secretion. The constitution and action of the secretion are identical with those of *Drosera*, as is probably the manner of transmission of the motor impulse. But want of space again excludes many interesting details.

Aldrovanda, *Drosophyllum*, *Roridula*, and *Byblis*, four other genera of the same order, all are provided with secreting glands and seem to have similar powers, though in a lesser degree.

Mr. Darwin was also led to investigate the habits of *Pinguicula*

vulgaris, the result being to establish beyond question the predatory practices of the bladderwort, a plant which had hitherto enjoyed a good name.

It is not provided with any irritable filaments, the sensitiveness residing in the surface of the leaf, which is set with two kinds of glandular hairs secreting an extremely viscid fluid which seems to be the only agent for entrapping the insects. When once caught they are detained by the slowly-inflecting leaf. Here, too, contact with nitrogenous bodies changes the nature of the secretion, so that it becomes

FIG. 7.—PINGUICULA VULGARIS.—Outline of leaf with left margin inflected over a row of small flies.

FIG. 8.—PINGUICULA VULGARIS.—Outline of leaf, with right margin inflected against two square bits of meat.

capable of dissolving and digesting insects and other nutritious substances, when the secretion and the digested matter are reabsorbed by the glands. When the objects are too large to be inclosed by the inflected leaf, they are by its incurving pushed along over the surface, constantly coming in contact with fresh and hungry glands, subserving the needs of the plants as well as by the other method (*see* Fig. 8).

Utricularia neglecta and U. vulgaris (*common Bladderwort*).—It will be a new revelation to most readers to be told that the bladders of this plant are not, as the manuals have always stated, filled with air and intended to float the plant, but that their real use is to capture small aquatic animals, which they do on a large scale.

The general appearance of a bladder is shown in the figure (10) given below. The lower side is straight, the other surface convex and terminating in two long prolongations bearing six or seven long pointed bristles. The prolongations are called antennæ, for, as Mr. Darwin says, "the whole bladder curiously resembles the entomostracean crustacea" upon which they prey so freely.

Under these antennæ, where the bladder is slightly truncated, is situated the most curious and important part of the whole structure, namely, the entrance and valve.

The valve is attached on all sides to the bladder, excepting by its posterior margin, which is very thin, and rests on a collar or rim, which dips deeply into the bladder. The valve can only open in-

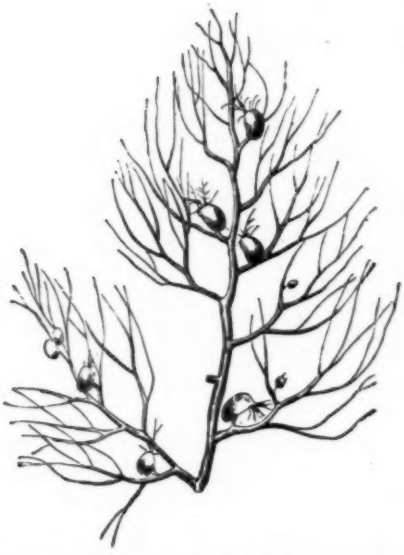

FIG. 9.—UTRICULARIA NEGLECTA.—Branch with the divided leaves bearing bladders; about twice enlarged.

ward; there are on its surface numerous glands, which have the power of absorption, but are not known to secrete.

The whole inner surface of the bladder is covered with a serried mass of processes, consisting each of four divergent arms, whence they

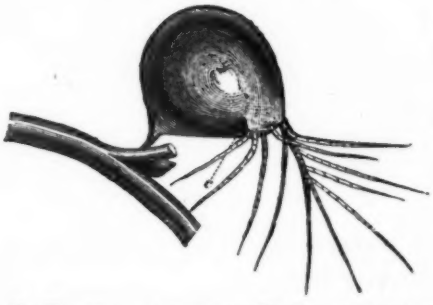

FIG. 10.—UTRICULARIA NEGLECTA.—Bladder, much enlarged.

are called quadrifid processes. Each arm generally contains a minute, faintly-brown particle, either rounded or elongated, which shows incessant Brownian movements.

Whenever found in stagnant water the bladders swarm with in-

sects, crustaceans, larvæ, and fresh-water worms, in various stages of decay. The animals enter the bladder by bending in the free edge of the valve, which shuts again instantly. How it is that such weak and minute animals get into the bladders is not yet understood, but they do succeed in entering as do inanimate objects, if laid upon the valve. The locality of the irritability, if indeed there be any, is not determined.

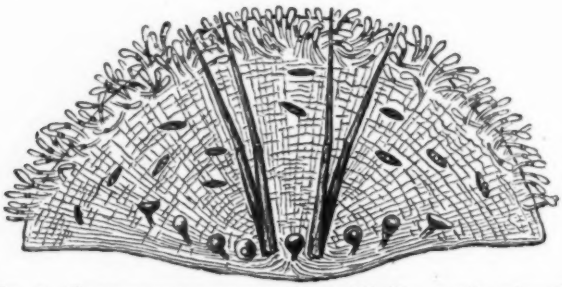

FIG. 11.—UTRICULARIA NEGLECTA.—Valve of bladder, greatly enlarged.

Notwithstanding the elaborate mechanism for the capture of animal food, there seems to be no power of digesting it, nor for hastening its decay; although, when decomposition sets in, its products are slowly absorbed by the quadrifid processes; at least, these processes from bladders containing decayed animals generally show masses of spontaneously-moving protoplasm which do not appear in those taken from clean bladders.

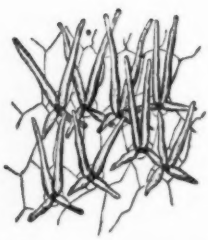

FIG. 12.—UTRICULARIA NEGLECTA.—Small portion of inside of bladder, much enlarged, showing quadrifid processes.

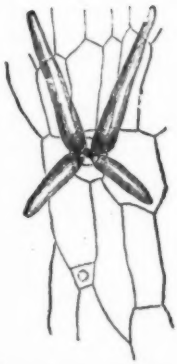

FIG. 13.—UTRICULARIA NEGLECTA.—One of the quadrifid processes greatly enlarged.

Investigations were extended to many other species of *Utricularia*, with results showing, in all cases, an adaptation for capturing small animals and power to absorb the products of their decay.

To be classed with this genus, as being insectivorous to a similar extent, are *Sarracenia* and *Darlingtonia*. Upon these Mr. Darwin records no observations.

Sarracenia variolaris has, however, had its powers carefully investigated by Dr. Mellichamp, of Bluffton, South Carolina. This species differs from the common Northern one (*S. purpurea*) chiefly in having a lid which closes over the mouth of the trumpet-shaped leaves, so that rain can not readily enter. The leaves are usually half-filled with a fluid which Dr. Mellichamp is satisfied is secreted at the bottom of the tubes. He describes it as mucilaginous, and leaving in the mouth a peculiar astringency. In it meat decomposes more rapidly than in water, and he concludes that as the leaves when stuffed with insects become most disgusting in odor, we have to do with an accelerated decomposition, though not with digestion. He attributes anæsthetic effects to the fluid. The lure which brings the insects to the mouth of the pitcher is a honey-baited pathway running from the ground along the broad wing of the pitcher to its mouth, up which the insects are lured to their fate. Nothing of this kind is observed in *S. purpurea*, and its exposed mouth is so placed that rain must fall into it. It is not probable, as Dr. Hooker says, that pitchers presenting such differences should act similarly, and he adds: "The fact that insects normally decompose in the fluid of all would suggest the probability that all feed on the products of decomposition; but as yet we are ignorant whether the glands within the pitchers are secretive or absorptive, or both; if secretive, whether they secrete water or a solvent; if absorptive, whether they absorb animal matter or the products of decomposition."

Prof. C. V. Riley (American Association for the Advancement of Science, 1874) is of opinion that the only benefit to the plant is from the liquid manure.

But this fascinating subject cannot be pursued further.

Sentimental flower-worshipers, fond of quoting the pretty metaphor of their buds and blossoms being "truly the language of angels," will doubtless be pained to learn that they are not all ethereal creatures subsisting on such lovely foods as dew and sunlight, but that they are at times given to dining off the more substantial fricassees which their alert tentacles know so well how to prepare. And although they may consign the sanguinary *Droseras* and *Dionæas* to the limbo of the unclean, and turn with renewed admiration to their own floral pets, still the matter does not end here. Mr. Darwin throws out some dark hints as to the private lives of the immaculate *Primula*, the brilliant *Pelargonium* and other greenhouse favorites, that must lead the thoughtful mind to conclude that that they will at least bear watching.

Seriously, these revelations afford abundant food for thought. There are three remarkable powers connected with the phenomenon: the movement of the leaves when excited; the secreting of a digestive fluid; the absorption of digested matter. The species possessing them all hold them in different degree; some possess two and others but one of them. What light can natural selection throw upon the

steps by which these wonderful powers were gradually acquired? is one of the problems presented to the evolutionist.

Mr. Darwin submits his work wonderfully advanced when compared with the state in which he found it, but there remains much to be done.

INDUCED DISEASE FROM THE INFLUENCE OF THE PASSIONS.[1]

By B. W. RICHARDSON, M. D., F. R. S.

MANY of the forms of disease previously detailed may be induced by other causes than worry or mental strain. They may be the effects of the unrestrained influence of certain of the passions. I say certain of the passions, because all do not seem to act with the same intensity. Some of them act with a sharpness of intensity that is peculiar, while others apparently excite no physical injury.

The passions which act most severely on the physical life are anger, fear, hatred, and grief. The other passions are comparatively innocuous. What is called the passion of love is not injurious until it lapses into grief and anxiety; on the contrary, it sustains the physical power. What is called ambition is of itself harmless; for ambition, when it exists purely, is a nobility lifting its owner entirely, from himself into the exalted service of mankind. It injures when it is debased by its meaner ally, pride; or when, stimulating a man to too strenuous efforts after some great object, it leads him to the performance of excessive mental or physical labor and to the consequences that follow such effort.

The passion called avarice, according to my experience, tends rather to the preservation of the body than to its deterioration. The avaricious man, who seems to the luxurious world to be debarring himself of all the pleasures of the world, and even to be exposing himself to the fangs of poverty, is generally placing himself in the precise conditions favorable to a long and healthy existence. By his economy, he is saving himself from all the worry incident to penury; by his caution he is screening himself from all the risks incident to speculation or the attempt to amass wealth by hazardous means; by his regularity of hours and perfect appropriation of the sunlight, in preference to artificial illumination, he rests and works in periods that precisely accord with the periodicity of Nature; by his abstemiousness in living he takes just enough to live, which is precisely the right thing to do according to the rigid natural law. Thus, in almost

[1] From advance sheets of a new work in press of D. Appleton & Co., entitled "The Diseases of Modern Life."

every particular, he goes on his way freer than other men from the external causes of all the induced diseases, and better protected than most men from the worst consequences of those diseases which spring from causes that are uncontrollable.

I do not hold up this picture as an encouragement to avarice, for an avaricious world would truly be a sad one. "But there is a soul of goodness in things evil, would men observingly distill it out," and, certainly, much goodness might be observed even in the perverted passion of avarice, if reckless and over-generous men would condescend to the distillation.

Some of the most extreme instances, at all events, nay, the most typical instances, of longevity with perfect physical health that I have met with, have been in those who are tinctured practically with the passion under consideration. It is true some have not been happy, and none eminently useful; but to the physiological mind they present a remarkable picture of the endurance of health and life under what are nearest to the natural conditions necessary for both. They suggest that if with this physical standard a higher and nobler mental development could be attained, with art and science and benevolent labors as the pleasures added to the life, the approach to perfection of existence would be closely realized, and the age, not of the man only but of the world of life to which he belongs, would be more thoughtfully conserved.

Of the passions I have enumerated as most detrimental to life, anger stands first. He is a man very rich indeed in physical power who can afford to be angry. The richest cannot afford it many times without insuring the penalty, a penalty that is always severe. What is still worse of this passion is, that the very disease it engenders feeds it, so that if the impulse go many times unchecked it becomes the master of the man.

The effects of passion are brought out entirely through disturbance in the organic nervous chain. We say a man was "red" with rage, or we say he was "white" with rage, by which terms, as by degrees of comparison, we express the extent of his fury. Physiologically we are then speaking of the nervous condition of the minute circulation of his blood: that "red" rage means partial paralysis of minute blood-vessels: that "white" rage means temporary suspension of the action of the prime mover of the circulation itself. But such disturbances cannot often be produced without the occurrence of permanent organic evils of the vital organs, especially of the heart and of the brain.

The effect of rage upon the heart is to induce a permanently perverted motion, and particularly that perverted motion called intermittency. One striking example, among others of this kind which I could name, was afforded me in the case of a member of my own profession. This gentleman told me that an original irritability of temper was

permitted, by want of due control, to pass into a disposition of almost persistent or chronic anger, so that every trifle in his way was a cause of unwarrantable irritation. Sometimes his anger was so vehement that all about him were alarmed for him even more than for themselves, and when the attack was over there were hours of sorrow and regret, in private, which were as exhausting as the previous rage. In the midst of one of these outbreaks of short, severe madness, he suddenly felt, to use his own expression, as if his "heart were lost." He reeled under the impression, was nauseated and faint: then, recovering, he put his hand to his wrist, and discovered an intermittent action of his heart as the cause of his faintness. He never completely rallied from that shock, and to the day of his death, ten years later, he was never free from the intermittency. As a rule he was not conscious of the intermittency unless he took an observation on his own pulse, as though he were apart from himself: but occasionally after severe fatigue he would be subjectively conscious of it, and was much distressed and depressed. "I am broken-hearted," he would say, "physically broken-hearted." And so he was: but the knowledge of the broken heart tempered, marvelously, his passion, and saved him many years of a really useful life. He died ultimately from an acute febrile disorder.

The effect of anger upon the brain is to produce first a paralysis, and afterward, during reaction, a congestion of the vessels of that organ; for, if life continues, reactive congestion follows paralysis as certainly as day follows night. Thus, in men who give way to violent rage there comes on, during the acute period, what to them is merely a faintness, which, after a time of apparent recovery, is followed by a slight confusion, a giddiness, a weight in the head, a sense of oppression, and a return to equilibrium. They are happy who, continuing their course, suffer no more severely. Many die in one or other of the two stages I have named. They die in the moment of white rage, when the cerebral vessels and heart are paralyzed. Then we say they die of faintness, after excitement. Or, they die more slowly when the rage has passed and the congestion of reaction has led to engorgement of the vessels of the brain. Then the engorgement has caused stoppage of the circulation there; or a vessel has given way; or serous fluid has exuded, producing pressure, and we report that the death was from apoplexy, following upon some temporary excitement.

Hatred, when it is greatly intensified, acts much like anger in the effects it produces. The phenomena differ in that they are less suddenly developed and more closely concealed; they very rarely, in fact, come under the cognizance of the physician unmixed with other phenomena. They are made up of the symptoms of suppressed anger with morose determination, and they keep the sufferer from rest. He is led to neglect the necessities of his own existence; he is rendered

feverish and feeble; and at last he either sinks into chronic despondency and irritability, or rushes hastily to the performance of some act which indicates disordered mind.

The effects of fear are all but indentical with those of rage, and like rage grow in force with repetition. The phenomena are so easily developed in the majority of persons, they may actually be acquired by imitation, and may be intensified and perhaps induced by listening to the mere narratives of events which act as causes of fear. I am daily more and more convinced that not half the evils resulting from what may be called the promptings of fear in the young and the feeble are duly appreciated, and that fear is the worst weapon of physical torture the thoughtless coward wields. The organs upon which fear exerts its injurious influence are, again, the organic nervous chain, the heart, and the brain.

Permanent intermittency of the heart is one of the leading phenomena incident to sudden and extreme terror. One example, sufficiently characteristic, will illustrate this fact:

A gentleman of middle age was returning home from a long voyage in the most perfect health and spirits, when the vessel in which he was sailing was struck from a collision, and, hopelessly injured, began to sink. With the sensation of the sinking of the ship and the obvious imminence of death—five minutes was the longest expected period of remaining life—this gentleman felt his heart, previously acting vehemently, stop in its beat. He remembered then a confused period of noise and cries and rush, and a return to comparative quiet, during which he discovered himself being conveyed, almost unconsciously, out of the sinking vessel on to the deck of another vessel that had rendered assistance. When he had gained sufficient calmness he found that periods of intermittent action of his heart could be counted. They occurred four and five times in the minute for several days, and interfered with his going to sleep for many nights. On reaching land the intermittency decreased, and when the patient came to me, soon afterward, there were not more than two intermittent strokes in the minute, all the intervening strokes being entirely natural and the action of the heart and the sounds of it being simply perfect. In this gentleman the intermittent pulse became a fixed condition, but so modified in character that it was endurable. At his last visit to me he was not conscious of the symptom except he took it objectively from himself, by feeling his own pulse or listening to his own heart.

The effect of fear on the brain may be to the extent of that which is produced by extremity of rage, so that even sudden death, from syncope, may ensue. I have known two such instances as these, but the more common effect is an intense irritability, followed by doubt, suspicion, and distrust, leading toward or to insanity. From a sudden terror deeply felt the young mind rarely recovers, never, I believe, if hereditary tendency to insanity be a part of its nature. A man,

who is now the inmate of an asylum, owing to fixed delusions that all his best friends are conspiring to injure and kill him, explained to me, before his delusion was established, from what it started. When he was a boy he had a nervous dread of water, and his father, for that very reason, and with the best of intentions, determined that he should be taught to swim. He was taken by his tutor, in whom he had every confidence, to the side of a river, and when he was undressed he suddenly found himself cast by his instructor, without any warning, into the stream. No actual danger of drowning was implied, for the tutor himself was at once in the water to hold him up or to bring him to land; but the immediate effect, beginning with the faintness of fear, was followed by vomiting, by a long train of other nervous symptoms, by constant dread that some one was in some way about to repeat the infliction, by frequent dreaming of the event by night, by thinking upon it in the day. At last all the phenomena culminated in that breach between the instinctive and the reasoning powers which we, for want of a better term, call dangerous and insane delusion.

The effect of grief varies somewhat according to the suddenness or slowness with which it is expressed. Sudden grief tells chiefly upon the heart, leading to irregular action, and to various changes in the extreme parts of the circulation incidental to such irregularity. Under sudden impulse of grief I have known singular local manifestations of disease, as for instance the development of a *goître;* an hæmoptysis or loss of blood from the lungs; a local paralysis of the lip and tongue; a failure of sight.

When the grief is less sudden and more prolonged, want of power and intermittency of the circulation are again the most common phenomena. They are most easily developed in women, but I have seen them occur even in men of strong habit but sensitive feeling. Thus a gentleman whom I know well, and who suffers in the way I describe, tells me that he first became conscious of the intermittency in the action of his heart, upon the anxiety he felt from the loss of one of his brothers, to whom he was deeply attached and for whose superior talents he had, as indeed many others had, a profound admiration. The attacks at first were so severe that they created in his mind some alarm; but in course of time he became accustomed to them, and the sense of fear passed away. The intermittency in this instance alternated with periods in which there was very slight interruption of natural action. During the more natural periods there was, however, an occasional absence of stroke once in two or three hundred beats, but the fact was not evident to the subject himself. When the extreme attacks were present the intermittency of pulse occurred six or even seven times in the minute, and the fact, which was subjectively felt, was very painful. The stomach at the same time was uneasy, there were flatulency and a sensation of sinking and exhaustion. In the worst attacks there was also some difficulty in respiration, and a

desire for more capacity for air, but unattended by spasm or acute pain. A severe attack was induced readily by any cause of disturbance, such as broken rest or mental excitement; on the other hand, rest and freedom from care seemed to him curative, for a time.

In this gentleman another symptom was presented for one or two years, which is somewhat novel, and exceedingly striking. The symptom was this: When the intermittent action of the heart was at its worst, there came on in the fingers of one or other hand a sensation of coldness and numbness, followed instantly by quick blanching of the skin, precisely the same appearance, in fact, as is produced when the surface of the body is frozen. The numbness and temporary death of the parts would often remain for a full hour, during which time the superficial sensibility was altogether lost. When recovery commenced in the fingers it was very rapid, and after recovery no bad results were ever noticeable. I have since seen one similar illustration in another individual, occurring under nearly similar circumstances.

From the irregularity of the circulation of the blood induced by prolonged grief, varied central phenomena in the nervous matter follow, and in persons who have passed middle life these phenomena are usually permanent if not progressive. They consist of organic feebleness extending to all the active organs of the body, and affecting specially the mental organism. A constant desire for rest, for avoidance of cares, for seclusion, mark this stage of disease, if so it may be called. It is not necessarily a stage leading to rapid failure of further physical or mental power, for the mind and body are subdued so equally that there is no galling irritability, no wearing depression from the influence of other passions. The worst that happens ultimately in those instances is the gradual but premature encroachment of dementia previous to death, if the life be prolonged to its natural term.

Under some circumstances the passions, excited in turn, injure by the combined influence of their action. In games of chance where money is at stake we see the play of the worst passions in all its mischievous intensity. Fear and anger, hate and grief, hope and exultation, stand forth, one after the other, keeping the trepitant heart in constant excitement and under tremulous strain, until at length its natural steadiness of motion is transformed into unnatural irregularity which, if it do not remain permanent, is called up by the slightest irritation. The act of playing at whist for high stakes is a frequent source of disease from this cause. I know that professed or habitual card-players declare that, however much may be played for, the losses and winnings of games are equalized by turn, and that after a year's play the player has, practically, neither won nor lost. I may accept that what is declared on this point is true; but the fact, if it be one, does not alter the physical evil that results, one iota. The man who, after being engaged in business all day, sits down regularly at night to play his rubbers on rubbers, to stake heavily on his games, to bet

on his odd tricks, never, I believe, escapes the effects of organic nervous shock. Some of the worst forms of such shock I have seen have sprung from this cause.

Political excitements call forth readily the reel of the passions with dangerous energy. A few specially constructed men, who have no passions, pass through active political excitement and, maybe, take part in it without suffering injury; but the majority are injured. As they pour forth their eloquent or rude speeches, as they extol or condemn, as they cheer or hiss, as they threaten or cajole, they are taking out of themselves force they will never regain.

It has been observed since the time of Pinel, that when to political excitement there is added the excitement of war, especially of civil war, the effects on the physical life of the people is at once marked by the disturbance of nervous balance. This fact was forcibly illustrated during and after the last great civil war in America, and it formed the subject of several most able reports by the physicians of that country. One report, by Dr. Stokes, of the Mount Hope Institution of Baltimore, was, I remember, a masterly history which, when the time comes that war shall be no more, will be read with as much wonder as we now read of the witch or dancing mania of the middle ages. One victim of the war mania is cursed with fear until he fails to sleep; another believes all his estates are confiscated; a third imagines himself taking part in some bloody fray; a fourth, the subject of aural delusions, no sooner sleeps than he wakes up, roused by what he considers to be awful sounds afar off, but approaching nearer. These are the more visible evidences of the injuries of war beyond those inflicted on the fighting-men. They represent much, but they represent little if they be compared with the minor but still formidable physical injuries to the heart and brain which stop short of real insanity, but which reduce life, and which pass in line from the generation that receives them primarily to the generations that have to come.

The reel of the passions as a cause of diseases of modern life rests not with the excitements of gaming, of political strife, of war. It is stirred up by some fanatical manifestations for the regeneration of the world, which are well meant, but which, missing the mark, plant degeneration instead.

In a sentence, whenever, from undue excitement of any kind, the passions are permitted to overrule the reason, the result is disease: the heart empties itself into the brain; the brain is stricken, the heart is prostrate, and both are lost.

THE PROPERTIES OF PROTOPLASM.[1]

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THE term protoplasm, from Gr. *πρῶτος*, *first*, and *πλάσμα*, *form*, is applied to the supposed original substance from which all living beings are developed, and which is the universal concomitant of every phenomenon of life. All that is comprehended for brevity under the term life, whether the growth of plants, the flight of birds, or a train of human thought, is thus supposed to be caused by corporeal organs which either themselves consist of protoplasm, or have been developed out of it. Wherever nutrition and propagation, motion and sensation exist, there is as their material basis this substance designated in a general sense as protoplasm. The proof of it is held to be furnished by the protozoans called moners, the whole completely developed body of which consists solely of protoplasm. They are not only the simplest organisms with which we are acquainted, but also the simplest living beings we can conceive of as capable of existing; and though their entire body is but a single, formless, small lump of protoplasm, and (each molecule of it being like the other) without any combination of parts, yet they perform all the functions which in their entirety constitute in the most highly-organized animals and plants what is comprehended in the idea of life, namely, sensation and motion, nutrition and propagation. By examining these moners we shall gain a clear conception of the nature of protoplasm, and understand the important biological questions connected with the theory.

Some moners live in fresh water, and others in the sea. They are as a rule invisible to the naked eye, but some are as large as the head of a pin, and may be distinguished without the aid of a microscope. When completely at rest a moner commonly assumes the shape of a simple sphere. Either the surface of the body is quite smooth, or numerous exceedingly delicate threads radiate from it in all directions. These threads are not permanent and constant organs of the slime-like body, but perishable continuations of it, which alternately appear and disappear, and may vary every moment in number, size, and form. For this reason they are called false feet or pseudopodia. Nevertheless, by means of these pseudopodia the moners perform all the functions of the higher animals, moving them like real feet either to creep, climb, or swim. By means of these sticky threads they adhere to foreign bodies as with arms, and by shortening or elongating them they drag their own bodies after them. Each thread, like the whole body, is capable of being contracted, and every portion of it is as sensitive and excitable as the entire form. When any point on the

[1] From the forthcoming volume of Appletons' "American Cyclopædia."

surface of the body is touched with the point of a pin, or with another body producing a chemical alteration, as for example a small drop of acid, or when a current of electricity is passed through it, the threads are drawn in, and the entire body contracts into the form of a spherical lump. The same threads perform also the function of providing alimentation.

When a small infusorium or any other nutritive particle comes accidentally in contact with the extended pseudopodia, these run quickly over it like a fluid, wind around it with their numerous little branches, fuse into one, and press it into the interior of the body, where all the nutritive portions are rapidly absorbed and immediately assimilated, while all that is useless is quickly ejected.

The variations among the different moners, of which so far sixteen kinds have been described (Haeckel's "Monographie der Moneren)," consist partly in the various forms of the pseudopodia, but especially in the different kinds of propagation. Some of them merely divide into halves on reaching a certain size; others put forth little buds which gradually separate from them; and others experience a sudden division of the mass into numerous small spherical bodies, each of which instantly begins a separate existence and gradually reaches the size of the ancestral organism.

The chemical examination of the homogeneous protoplasmic body shows that it consists throughout of an albuminous or slime-like mass, hence of that azotic carbonate of the character of the highly-compounded connective group called proteine, albuminoids, or plasson bodies. Like other chemical compounds of this group, protoplasm exhibits several reactions which distinguish it from all others. It is easy to detect it under the microscope, on account of the facility with which it combines with certain coloring matters, as carmine and aniline; it is colored dark yellow or yellowish brown by iodine and nitric acid; and it is coagulated by alcohol and mineral acids, as well as by heat. The quantitative composition of protoplasm, though in some cases greatly varying, resembles as a whole that of other albuminoids, and hence consists of from fifty to fifty-five per cent. of carbon, probably six to eight of hydrogen, fifteen to seventeen of nitrogen, twenty to twenty-two of oxygen, and one to two of sulphur. Protoplasm possesses the quality of absorbing water in various quantities, which renders it sometimes extremely soft and nearly liquid, and sometimes hard and firm like leather; but it is usually of a medium degree of density. Its more prominent physical qualities are excitability and contractility, which Kühne and others have made a special subject of investigation.

On examining with the microscope the numerous substances constituting the various organs of the higher animals, it appears that they all consist of a large number of minute elements, known since Schleiden and Schwann (1838) by the name of cells; and in these cells pro-

toplasm is the oldest, most primordial, and most important constituent. In every real cell there is, besides protoplasm, and while still alive and independent, a second important constituent, the cellular germ, so called (nucleus or cytoblast); but even this germ consists of an albuminous chemical compound which is closely related to protoplasm, and was orginally produced from it by an exceedingly slight chemical alteration. The germ is usually a smaller and firmer formation within the protoplasm of the cell.

Inasmuch as the idea of an organic cell, as now adopted by histologists, rests on the presence of two different essential parts in this elementary organism, the internal cell and the external protoplasm, we must distinguish also two different kinds of elementary organisms: germless cytods, as moners for example, and the real germ-inclosing cells, which originate from the former by secreting in the interior of the small mass of protoplasm a true germ or nucleus. Cells of the simplest kind consist only of protoplasm with a nucleus, while in general the cells of animal or vegetable bodies have also other constituents, particularly and frequently an inclosing skin or capsule (the cellular membrane), also crystals, grains of fat, pigments, and the like, within the protoplasm. But all of these parts came into being only secondarily through the chemical action of protoplasm; they are but the internal and external products of protoplasm. (Haeckel's "Generelle Morphologie," vol. i., p. 279). The single cell of the simplest kind is able to exist as an independent organism. Many of the lowest plants and animals, and also many neutral *protista* (which are neither animals nor plants), retain for life the character of a simple cell. Such unicellular organisms of the simplest kinds are the *amœbæ*, found in large numbers as well in fresh as in salt water. Amœbæ are simple naked cells of various and varying forms. The whole difference between them, especially *protamœbæ*, and certain moners, is that they have a germ. It is probable that this germ of the amœbæ (as may be supposed to be the case with many and perhaps all other cells) is only an organ of propagation, and hence of heredity; while all the other functions, alimentation, motion, and sensation, are performed by the protoplasm. This seems to indicate that at the reproduction of the cells, which is usually effected by segmentation, it is the germ which first divides in two, and that the protoplasm afterward gathers around each of the two sister germs till it also falls in two. It is impossible to distinguish from the common amœbæ the cellular ovules of many of the inferior animals, as for example the sponges, medusæ, and other plant-like animals. With these the eggs are simple naked cells, which, with the sponges especially, sometimes crawl about independently in the body of the animal, giving rise to the idea that they were a class of parasitic amœbæ. But with other animals also, and with most plants, the eggs of which generally obtain subsequently special and often very complicated encasements and other additions,

every egg is originally a simple cell. The seminal elements of the male are also only simple cells, and the entire mysterious process of fructification is after all nothing but the fusion or concrescence of two different cells, the one a female egg-cell, and the other a male semen-cell. In consequence of this fusion the germs of the two combined cells dissolve, and therewith the young, newly-generated individual begins his existence as a simple cytod, or a small germless ball of protoplasm. But inside of this cytod soon arises a new germ, which turns it again into a cell, and this simple cell forms by oft-repeated segmentation an accumulation of cells. Out of this heap are produced by secretion certain germinal layers or "germ-leaves," and out of these proceed all the other organs of the complete being. Each of these organs again originally consists only of cells, and in all of these cells the essential constituent parts are only the germ and protoplasm: the germ as the elementary organ of propagation and heredity, protoplasm as the elementary organ of all the other functions, sensation, motion, alimentation, and adaptation. Cells and cytods, therefore, are true elementary organisms, independent minute forms of life, which either in the lowest existences continue to live independently, or in the higher organisms combine in numbers to form a community. Cells and cytods are the veritable "formers" of life, or plastids. The most ancient and primordial forms of plastids are cytods, the whole body of which consists of protoplasm, in which the germs are internally produced, and from which therefore the cells proceed.

As a matter of course, to the infinite varieties presented by the organic forms and vital phenomena in the vegetable and animal kingdom, corresponds an equally infinite variety of chemical composition in the protoplasm. The most minute homogeneous constituents of this "life-substance," the protoplasm molecules, or plastidules, as they are called by Elsberg, must in their chemical composition present an infinite number of extremely delicate gradations and variations. The atoms of carbon, hydrogen, nitrogen, oxygen, and sulphur, which compose each of the plastidules, must enter into an infinite number of diverse stratifications and combinations. The chemistry of to-day, with its imperfect methods of investigation, is totally powerless before these intricate organic compounds, and it is possible only to surmise, from the infinitely varied physiological qualities of the numberless kinds of plastids, the infinite variety of plastidules out of which they are composed.

According to the plastid theory recently advanced, the great variety of vital phenomena is the consequence of the infinitely delicate chemical difference in the composition of protoplasm, and it considers protoplasm to be the sole active life-substance. This theory puts force and matter in living organisms into the same causal connection which has long been accepted for force and matter in inorganic bodies. This conception has been rapidly matured, especially in

the past twenty years, through the more exact information obtained in regard to the lowest kinds of organisms. Yet the idea had been grasped more than half a century ago; for the "primordial slime" which Lorenz Oken proclaimed in 1809 to be the original source of life, and the material basis of all living bodies, possessed in all essentials the same qualities and the same importance now ascribed to protoplasm; and the *sarcode* so called, which in 1835 was pointed out by the French zoölogist Félix Dujardin as the only living substance in the body of rhizopods and other inferior primitive animals, is identical with protoplasm. But when Schleiden and Schwann, in 1838, developed their cell theory, they were not acquainted with the fundamental significance of protoplasm. Even Hugo Mohl, who in 1846 was the first to apply the name protoplasm to the peculiar serous and mobile substance in the interior of vegetable cells, and who perceived its high importance, was very far from understanding its significance in relation to all organisms. Not until Ferdinand Cohn (1850), and more fully Franz Unger (1855), had established the identity of the animate and contractile protoplasm in vegetable cells and the sarcode of the lower animals, could Max Schultze in 1858–'61 elaborate this protoplasm theory of the sarcode, so as to proclaim protoplasm to be the most essential and important constituent of all organic cells, and to show that the bag or husk of the cell, the cellular membrane, and the intercellular substances, are but secondary parts of the cell, and are frequently wanting. In a similar manner Lionel Beale (1862) distinguished such primary forming and secondary formed substances in all organic tissues, and gave to protoplasm, including the cellular germ, the name of "germinal matter," and to all the other substances entering into the composition of tissues, being secondary and produced, the name of "formed matter."

The protoplasm theory received a wide and thorough illustration from the study of rhizopods which Ernst Haeckel published in 1862 in his "Monographie der Radiolarien," and its complete application in the "Generelle Morphologie der Organismen" by the same naturalist. Haeckel distinguishes in these works, for the first time, between germless protoplasm, consisting only of plastids called cytods by him, and the germ-containing real cells, the elementary organism of which consists already of two different essential parts, germ and protoplasm. He conceived the cytods and cells as two different gradations of plastids, of organic elementary individuals, or as "individuals of the first order," and adopted entirely, in regard to the individual independence of the plastids, the ideas which had been set forth by Rudolf Virchow and Ernst Brücke.

Virchow, whose "Cellular-Pathologie" contains the most complete application of the cell theory to pathology, called the cells and the "cell territories" belonging to them the individual hearth or source of life; Brücke designated them as "elementary organisms." The plas-

tids or individuals of the first order, identical with them, were determined by Haeckel phylogenetically, to the effect that cytods and cells must be distinguished as two essentially different orders of formation; i. e., that cells were phylogenetically produced in a secondary manner from homogeneous cytods by means of the secretion of a germ by the protoplasm. This distinction is important for the reason that many of the lowest orders of organisms have no germ in the protoplasm; such is the case especially with the moners. These simplest of organisms were first discovered by Haeckel in 1864, and described by him in 1868 in his "Monographie der Moneren." Cienkowski and Huxley also made valuable investigations of various moners. The latter discovered in 1868 the famous bathybius, a very remarkable kind of moner, which at immense depths covers the bottom of the sea in immeasurable numbers, and which consists of formless and variable protoplasm tissues of different sizes.

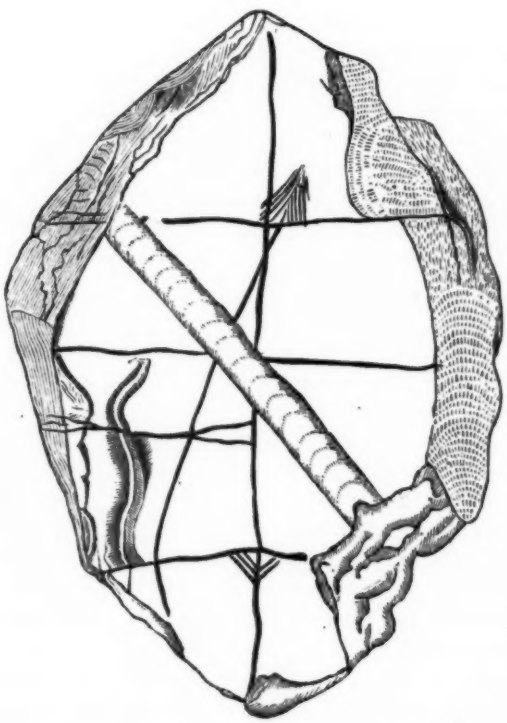
Among the moners investigated by Cienkowski, the most interesting are the vampire-cells, which are formless little bodies of protoplasm that bore into vegetable cells by means of their pointed pseudopodia, kill them, and absorb the protoplasm they find in them. On the basis of these discoveries Haeckel elaborated his plastid theory and carbon theory, which give the extremest philosophical consequences of the protoplasm theory.

In England the monistic philosophy of protoplasm has received the most weighty support from Huxley, whose "Protoplasm, or the Physical Basis of Life" (1868), put it in its true light, and called forth numerous writings for and against it. One of the most recent treatises in favor of it is that of James Ross "On Protoplasm" (1874). Probably the name of plasson will be given to the primordial, perfectly structureless, and homogeneous protoplasm of the moners and other cytods, in contradistinction to the protoplasm of germ-containing cells, which are produced only subsequently, by the differentiation of an internal nucleus and external protoplasm by the plasson bodies of moners. Édouard van Beneden especially calls for this distinction in his "Recherches sur l'évolution des grégarines;" and Haeckel has adduced new facts in favor of it in his "Monograpphie der Kalkschwämme." For the theory of "primordial generation," the spontaneous generation of the first vitality on earth, the distinction is of special importance, as the first organisms thus produced could have been only structureless specks of plasson, like the bathybius and other moners. The great theoretical difficulties formerly in the way of the theory of primordial or spontaneous generation have been removed by the discovery of the moners and the establishment of the plastid theory. As the protoplasm of the bathybius is not yet as much as individualized, while in the case of other moners there are individual lumps of constant sizes, it follows that the moners are to be regarded as the natural bodies which effect the transition from inorganic to organic Nature.

A CURIOUS INDIAN RELIC.

By CHARLES C. ABBOTT, M. D.

AMONG the several thousands of Indian relics gathered by the writer, in the immediate vicinity of Trenton, New Jersey, there has occurred one wholly different from all the others, and which bears some resemblance to the well-known Indian bark-letters, as figured by Schoolcraft and Catlin; but this inscribed stone is far more primitive than these. The specimen (as shown in the following diagram) is a slab of impure mica or micaceous slate, about an inch in thickness, seven inches in length, and four and three-fourths inches in



greatest width. The edges have been rudely beveled, and the specimen chipped into its present shape previous to the inscribing of the peculiar markings which characterize the relic.

These consist of a series of well-defined lines, one extending the entire length of the specimen, and dividing it into two nearly equal parts or surfaces. There are also three well-defined lines crossing

the central one at right angles, and a fourth short one, with "split" ends, on the left-hand side, below the centre of the slab.

The wide, shallow groove crossing obliquely from left to right is, I think, a subsequent marking, possibly from a ploughshare passing lightly over the stone. It has the appearance of having been done quite recently. Perhaps the most noticeable feature of the inscribed side of the stone is the well-defined arrow, extending obliquely across the specimen from right to left. This certainly helps one, at least, to imagine some plausible explanation of the meaning of the various markings.

The relic was found in a dense swamp, which until very lately has in no way been disturbed, otherwise than by cutting off the matured timber. Just where found it probably had been lying since the distant day when, for some purpose, it was placed in position by the aborigines.

That the specimen is really an Indian relic I am positive, having examined the spot where it was found; and from the fact that the lad that found it brought it to me with considerable doubt in his own mind as to its being really "Indian" work. In the immediate neighborhood were found quite a number of stone axes, spears, and arrow-points, all of them of the rudest workmanship.

As the specimen exhibits no attempt on the part of its primeval owner at ornamentation, not even polishing, it can scarcely be doubted that the markings upon it were placed there to express some fact to others who might find it; that it is a "bark-letter" written upon stone—a very primitive attempt at "picture-writing."

Admitting, then, that the specimen has been engraved, as we now find it, by an aborigine, I suggest the following as an explanation or interpretation of the various markings: The slab has been engraved and then placed in the trail which the Indian or party of them were following, with the long central line pointing due north or else in the direction of the trail. The crossing lines would indicate three days' journeys up to the time of "locating" the stone, or, more probably, that three streams of water had been crossed; and the direction of the arrow indicated the direction the party had taken from the point where the stone was placed, on leaving the trail they had been following.

That the specimen was intended to convey some such meaning, I have myself no doubt; but, looked at in any light, it is certainly a very remarkable form of "relic," and being (as yet) unique, in the enormous "find" from this neighborhood, I think goes to show it is really a "record" or "letter," as such "picture-writings" would naturally be made at rare intervals and under unusual circumstances.

The specimen is preserved in the Museum of the Peabody Academy of Science, at Salem, Massachusetts.

METEOROLOGY OF THE SUN AND EARTH.[1]

By Prof. BALFOUR STEWART, F.R.S.

SINCE the last meeting of the British Association, Science has had to mourn the loss of one of its pioneers, in the death of the veteran astronomer, Schwabe, of Dessau, at a good old age, not before he had faithfully and honorably finished his work. In truth, this work was of such a nature that the worker could not be expected long to survive its completion.

It is now nearly fifty years since he first began to produce daily sketches of the spots that appeared upon the sun's surface. Every day on which the sun was visible (and such days are more frequent in Germany than in this country), with hardly any intermission for forty years, this laborious and venerable observer made his sketch of the solar disk. At length this unexampled perseverance met with its reward in the discovery of the periodicity of sun-spots, a phenomenon which very speedily attracted the attention of the scientific world.

It is not easy to overrate the importance of the step gained when a periodicity was found to rule these solar outbreaks. *A priori* we should not have expected such a phenomenon. If the old astronomers were perplexed by the discovery of sun-spots, their successors must have been equally perplexed when they ascertained their periodicity. For while all are ready to acknowledge periodicity as one of the natural conditions of terrestrial phenomena, yet every one is inclined to ask what there can be to cause it in the behavior of the sun himself. Manifestly it can only have two possible causes. It must either be the outcome of some strangely hidden periodical cause residing in the sun himself, or must be produced by external bodies, such as planets, acting somehow in their varied positions on the atmosphere of the sun. But whether the cause be an internal or external one, in either case we are completely ignorant of its nature.

We can easily enough imagine a cause operating from the sun himself and his relations with a surrounding medium to produce great disturbances on his surface, but we cannot easily imagine why disturbances so caused should have a periodicity. On the other hand we can easily enough attach periodicity to any effect caused by the planets, but we cannot well see why bodies comparatively so insignificant should contribute to such very violent outbreaks as we now know sun-spots to be.

If we look within we are at a loss to account for the periodicity of solar disturbances, and if we look without we are equally at a loss to account for their magnitude. But, since that within the sun is hidden

[1] Opening Address in Section A, at the Bristol Meeting of the British Association.

from our view, it cannot surely be considered blameworthy if astronomers have directed their attention to that without and have endeavored to connect the behavior of sun-spots with the positions of the various planets. Stimulated no doubt by the success which had attended the labors of Schwabe, an English astronomer was the next to enter the field of solar research.

The aim of Mr. Carrington was, however, rather to obtain very accurate records of the positions, the sizes, and the shapes of the various sun-spots than to make a very extensive and long-continued series of observations. He was aware that a series at once very accurate and very extended is beyond the power of a private individual, and can only be undertaken by an established institution. Nevertheless, each sun-spot that made its appearance during the seven years extending from the beginning of 1854 to the end of 1860 was sketched by Mr. Carrington with the greatest possible accuracy, and had also its heliographic position, that is to say its solar latitude and longitude, accurately determined.

One of the most prominent results of Mr. Carrington's labors was the discovery of the fact that sun-spots appear to have a proper motion of their own—those nearer the solar equator moving faster than those more remote. Another was the discovery of changes, apparently periodical, affecting the disposition of spots in solar latitude. It was already known that sun-spots confined themselves to the sun's equatorial regions, but Mr. Carrington showed that the region affected was liable to periodical elongations and contractions, although his observations were not sufficiently extended to determine the exact length of this period.

Before Mr. Carrington had completed his seven years' labors, celestial photography had been introduced by Mr. Warren De la Rue. Commencing with his private observatory, he next persuaded the Kew Committee of the British Association to allow the systematic photography of the sun to be carried on at their observatory under his superintendence, and in the year 1862 the first of a ten years' series of solar photographs was begun. Before this date, however, Mr. De la Rue had ascertained, by means of his photoheliograph, on the occasion of the total eclipse of 1860, that the red prominences surrounding the eclipsed sun belong, without doubt, to our luminary himself.

The Kew observations are not yet finally reduced, but already several important conclusions have been obtained from them by Mr. De la Rue and the other Kew observers. In the first place the Kew photographs confirm the theory of Wilson that sun-spots are phenomena, the dark portions of which exist at a level considerably beneath the general surface of the sun; in other words, they are hollows, or pits, the interior of which is of course filled up with the solar atmosphere. The Kew observers were likewise led to associate the low temperature of the bottom of sun-spots with the downward carriage

of colder matter from the atmosphere of the sun, while the upward rush of heated matter was supposed to account for the faculæ or bright patches which almost invariably accompany spots. In the next place the Kew observers, making use not only of the Kew series but of those of Schwabe and Carrington, which were generously placed at their disposal, have discovered traces of the influence of the nearer planets upon the behavior of sun-spots. This influence appears to be of such a nature that spots attain their maximum size when carried by rotation into positions as far as possible remote from the influencing planet —that is to say, into positions where the body of the sun is between them and the planet. There is also evidence of an excess of solar action when two influential planets come near together. But, although considerable light has thus been thrown on the periodicity of sun-spots, it ought to be borne in mind that the cause of the remarkable period of eleven years and a quarter, originally discovered by Schwabe, has not yet been properly explained. The Kew observers have likewise discovered traces of a peculiar oscillation of spots between the two hemispheres of the sun, and finally their researches will place at the command of the observers the data for ascertaining whether centres of greater and lesser solar activity are connected with certain heliocentric positions.

While the sun's surface was thus being examined both telescopically and photographically, the spectroscope came to be employed as an instrument of research. It had already been surmised by Prof. Stokes, that the vapor of sodium at a comparatively low temperature forms one of the constituents of the solar atmosphere, inasmuch as the dark line D in the spectrum of the sun coincides in position with the bright line given out by incandescent sodium-vapor.

This method of research was greatly extended by Kirchhoff, who soon found that many of the dark lines in the solar spectrum were coincident with the bright lines of sundry incandescent metallic vapors, and a good beginning was thus made toward ascertaining the chemical constitution of the sun.

The new method soon brought forth further fruit when applied in the hands of Huggins, Miller, Secchi, and others, to the more distant heavenly bodies. It was speedily found that the fixed stars had constitutions very similar to that of the sun. But a peculiar and unexpected success was attained when some of the nebulæ were examined spectroscopically. To-day it seems (so rapidly has knowledge progressed) very much like recalling an old superstition to remind you that until the advent of the spectroscope the irresolvable nebulæ were considered to be gigantic and remote clusters of stars, the individual members of which were too distant to be separated from each other even with a telescope like that of Lord Rosse. But Mr. Huggins, by means of the spectroscope, soon found that this was not the case, and that most of the nebulæ which had defied the telescope gave indica-

tions of incandescent hydrogen gas. It was also found by this observer that the proper motions of some of the fixed stars in a direction to or from the earth might be detected by means of the displacement of their spectral lines, a method of research which was first enunciated by Fizeau. Hitherto, in such applications of the spectroscope, the body to be examined was viewed as a whole. It had not yet been attempted to localize the use of this instrument so as to examine particular districts of the sun, as for instance a sun-spot, or the red flames already proved by De la Rue to belong to our luminary. This application was first made by Mr. Lockyer, who in the year 1865 examined a sun-spot spectroscopically, and remarked the greater thickness of the lines in the spectrum of the darker portion of the spot.

Dr. Frankland had previously found that thick spectral lines correspond to great pressure, and hence the inference from the greater thickness of lines in the umbra of a spot is that this umbra or dark portion is subject to a greater pressure; that is to say, it exists below a greater depth of the solar atmosphere than the general surface of the sun. Thus the results derived from the Kew photoheliograph and those derived from the spectroscope were found to confirm each other. Mr. Lockyer next caused a powerful instrument to be constructed for the purpose of viewing spectroscopically the red flames round the sun's border, in the hope that if they consisted of ignited gas the spectroscope would disperse, and thus dilute and destroy the glare which prevents them from being seen on ordinary occasions.

Before this instrument was quite ready these flames had been analyzed spectroscopically by Captain Herschel, M. Janssen, and others, on the occasion of a total eclipse occurring in India, and they were found to consist of incandescent gas, most probably hydrogen. But the latter of these observers (M. Janssen) made the important observation that the bright lines in the spectrum of these flames remained visible even after the sun had reappeared, from which he argued that a solar eclipse is not necessary for the examination of this region.

Before information of the discovery made by Janssen had reached this country, the instrument of Mr. Lockyer had been completed, and he also found that by its means he was able to analyze at leisure the composition of the red flames without the necessity of a total eclipse. An atmosphere of incandescent hydrogen was found to surround our luminary, into which, during the greater solar storms, sundry metallic vapors were injected—sodium, magnesium, and iron, forming the three that most frequently made their appearance.

Here we come to an interesting chemical question.

It had been remarked by Maxwell and by Pierce as the result of the molecular theory of gases that the final distribution of any number of kinds of gas in a vertical direction under gravity is such that the density of each gas at a given height is the same as if all the other gases had been removed, leaving it alone. In our own atmosphere

the continual disturbances prevent this arrangement from taking place, but in the sun's enormously extended atmosphere (if, indeed, our luminary be not nearly all gaseous) it appears to hold, inasmuch as the upper portion of this atmosphere, dealing with known elements, apparently consists entirely of hydrogen. Various other vapors are, however, as we have seen, injected from below the photosphere into the solar atmosphere on the occasion of great disturbances, and Mr. Lockyer has asked the question, whether we have not here a true indication of the relative densities of these various vapors derived from the relative heights to which they are injected on such occasions.

This question has been asked, but it has not yet received a definite solution, for chemists tell us that the vapor densities of some of the gases injected into the sun's atmosphere on the occasion of disturbances are, as far as they know from terrestrial observations, different from those which would be indicated by taking the relative heights attained in the atmosphere of the sun. Mr. Lockyer has attempted to bring this question a step nearer to its solution by showing that the vapors at the temperatures at which their vapor densities have been experimentally determined are not of similar molecular constitution, whereas in the sun we get an indication, from the fact that all the elements give us line spectra, that they are in similar molecular states.

Without, however, attempting to settle this question, I may remark that we have here an interesting example of how two branches of science—physics and chemistry—meet together in solar research.

It had already been observed by Kirchhoff that sometimes one or more of the spectral lines of an elementary vapor appeared to be reversed in the solar spectrum, while the other lines did not experience reversal. Mr. Lockyer succeeded in obtaining an explanation of this phenomenon. This explanation was found by means of the method of localization already mentioned.

Hitherto, when taking the spectrum of the electric spark between the two metallic poles of a coil, the arrangements were such as to give an average spectrum of the metal of these poles; but it was found that, when the method of localization was employed, different portions of the spark gave a different number of lines, the regions near the terminals being rich in lines, while the midway regions give comparatively few.

If we imagine that in the midway regions the metallic vapor given off by the spark is in a rarer state than that near the poles, we are thus led to regard the short lines which cling to the poles as those which require a greater density or nearness of the vapor-particles before they make their appearance; while, on the other hand, those which extend all the way between the two poles come to be regarded as those which will continue to make their appearance in vapor of great tenuity.

Now, it was remarked that these long lines were the very lines

which were reversed in the atmosphere of the sun. Hence, when we observe a single coincidence between a dark solar line and the bright line of any metal, we are further led to inquire whether this bright line is one of the long lines which will continue to exist all the way between two terminals of that metal when the spark passes.

If this be the case, then we may argue with much probability that the metal in question really occurs in the solar atmosphere; but if, on the other hand, the coincidence is merely between a solar dark line and a short bright one, then we are led to imagine that it is not a true coincidence, but something which will probably disappear on further examination. This method has already afforded us a means of determining the relative amount of the various metallic vapors in the sun's atmosphere. Thus, in some instances all lines are reversed, whereas in others the reversal extends only to a few of the longer lines.

Several new metals have thus been added to the list of those previously detected in the solar atmosphere, and it is now certain that the vapors of hydrogen, potassium, sodium, rubidium, barium, strontium, calcium, magnesium, aluminium, iron, manganese, chromium, cobalt, nickel, titanium, lead, copper, cadmium, zinc, uranium, cerium, vanadium, and palladium, occur in our luminary.

I have spoken hitherto only of telescopic spectroscopy; but photography has been found capable of performing the same good service toward the compound instrument consisting of the telescope and its attached spectroscope, which it had previously been known to perform toward the telescope alone. It is of no less importance to secure a permanent record of spectral peculiarities than it is to secure a permanent record of telescopic appearances. This application of photography to spectrum observations was first commenced on a sufficient scale by Mr. Rutherford, of New York, and already promises to be one of the most valuable aids in solar inquiry.

In connection with the spectroscope I ought here to mention the names of Respighi and Secchi, who have done much in the examination of the solar surface from day to day. It is of great importance to the advancement of our knowledge, that two such competent observers are stationed in a country where the climate is so favorable to continued observation.

The examination of the sun's surface by the spectroscope suggests many interesting questions connected with other branches of science. One of these has already been alluded to. I may mention two others put by Mr. Lockyer, premising, however, that at present we are hardly in a position to reply to them. It has been asked whether the very high temperatures of the sun and of some of the stars may not be sufficient to produce the disassociation of those molecular structures which cannot be disassociated by any terrestrial means; in other words, the question has been raised, whether our so-called elements are really elementary bodies.

A third question is of geological interest. It has been asked whether a study of the solar atmosphere may not throw some light upon the peculiar constitution of the upper strata of the earth's surface, which are known to be of less density than the average interior of our planet.

If we have learned to be independent of total eclipses as far as the lower portions of the solar atmosphere are concerned, it must be confessed that as yet the upper portions—the outworks of the sun—can only be successfully approached on these rare and precious occasions. Thanks to the various government expeditions dispatched by Great Britain, by the United States, and by several Continental nations—thanks, also, to the exertions of Lord Lindsay and other astronomers—we are in the possession of definite information regarding the solar corona.

In the first place, we are now absolutely certain that a large part of this appendage unmistakably belongs to our luminary, and in the next place, we know that it consists, in part at least, of an ignited gas giving a peculiar spectrum, which we have not yet been able to identify with that of any known element. The temptation is great to associate this spectrum with the presence of something lighter than hydrogen, of the nature of which we are yet totally ignorant.

A peculiar physical structure of the corona has likewise been suspected. On the whole, we may say that this is the least known, while it is perhaps the most interesting, region of solar research; most assuredly it is well worthy of further investigation.

If we now turn our attention to matters nearer home, we find that there is a difficulty in grasping the facts of terrestrial meteorology no less formidable than that which assails us when we investigate solar outbreaks. The latter perplex us because the sun is so far away, and because also his conditions are so different from those with which we are here familiar; while, on the other hand, the former perplex us because we are so intimately mixed up with them in our daily lives and actions; because, in fact, the scale is so large and we are so near. The result has been that until quite recently our meteorological operations have been conducted by a band of isolated volunteers individually capable and skillful, but from their very isolation incapable of combining together with advantage to prosecute a scientific campaign. Of late, however, we have begun to perceive that, if we are to make any advance in this very interesting and practical subject, a different method must be pursued, and we have already reaped the first fruits of a more enlightened policy; already we have gained some knowledge of the constitution and habits of our atmosphere.

The researches of Wells and Tyndall have thrown much light on the cause of dew. Humboldt, Dové, Buys Ballot, Jelinek, Quetelet, Hansteen, Kupffer, Forbes, Welsh, Glaisher, and others, have done much to give us an accurate knowledge of the distribution of terrestrial temperature. Great attention has likewise been given to the rainfall

of Great Britain and Ireland, chiefly through the exertions of one individual, Mr. G. J. Symons.

To Dové we are indebted for the law of rotation of the wind, to Redfield for the spiral theory of cyclones, to Francis Galton for the theory of anti-cyclones, to Buchan for an investigation into the disposition of atmospheric pressure which precedes peculiar types of weather, to Stevenson for the conception of barometric gradients, to Scott and Meldrum for an acquaintance with the disposition of winds which frequently precedes violent outbreaks; and, to come to the practical application of laws, we are much indebted to the late Admiral Fitzroy and the system which he greatly helped to establish for our telegraphic warnings of coming storms.

Again, the meteorology of the ocean has not been forgotten. The well-known name of Maury will occur to every one as that of a pioneer in this branch of inquiry. Fitzroy, Leverrier, Meldrum, Toynbee, and others, have likewise done much; and it is understood that the meteorological offices of this and other maritime countries are now busily engaged upon this important and practical subject. Finally, the movements of the ocean and the temperatures of the oceanic depths have recently been examined with very great success in vessels dispatched by her Majesty's government; and Dr. Carpenter has by this means been able to throw great light upon the convection-currents exhibited by that vast body of water which girdles our globe.

It would be out of place to enter here more minutely into this large subject, and already it may be asked what connection has all this with that part of the address that went before it.

There are, however, strong grounds for supposing that the meteorology of the sun and that of the earth are intimately connected together. Mr. Broun has shown the existence of a meteorological period connected apparently with the sun's rotation; five successive years' observations of the barometer at Singapore all giving the period 25.74 days. Mr. Baxendell, of Manchester, was, I believe, the first to show that the convection-currents of the earth appear to be connected somehow with the state of the sun's surface as regards spots; and still more recently, Mr. Meldrum, of the Mauritius Observatory, has shown by a laborious compilation of ships' logs, and by utilizing the meteorological records of the island, that the cyclones in the Indian Ocean are most frequent in years when there are most sun-spots. He likewise affords us grounds for supposing that the rainfall, at least in the tropics, is greatest in years of maximum solar disturbance.

M. Poey has found a similar connection in the case of the West Indian hurricanes; and, finally, Piazzi Smyth, Stone, Köppen, and still more recently, Blanford, have been able to bring to light a cycle of terrestrial temperature having apparent reference to the condition of the sun.

Thus, we have strong matter-of-fact grounds for presuming a con-

nection between the meteorology of our luminary and that of our planet, even although we are in complete ignorance as to the exact nature of this bond.

If we now turn to terrestrial magnetism, the same connection becomes apparent.

Sir Edward Sabine was the first to show that the disturbances of the magnetism of the earth are most violent during years of maximum sun-spots. Mr. Broun has shown that there is likewise a reference in magnetic phenomena to the period of the sun's rotation about his axis, an observation recently confirmed by Hornstein; and still more recently, Mr. Broun has shown that the moon has an action upon the earth's magnetism which is not altogether of a tidal nature, but depends, in part, at least, upon the relative position of the sun and moon.

I must trust to your forbearance if I now venture to bring forward considerations of a somewhat speculative nature.

We are all familiar with the generalization of Hadley, that is to say, we know there are under-currents sweeping along the surface of the earth from the poles to the equator, and upper-currents sweeping back from the equator to the poles. We are likewise aware that these currents are caused by the unequal temperature of the earth; they are in truth convection-currents, and their course is determined by the positions of the hottest and coldest parts of the earth's surface. We may expect them, therefore, to have a reference not so much to the geographical equator and poles as to the hottest and coldest regions. In fact, we know that the equatorial regions, into which the trade-winds rush and from which the anti-trades take their origin, have a certain annual oscillation depending upon the position of the sun, or, in other words, upon the season of the year. We may likewise imagine that the region into which the upper-currents pour themselves is not the geographical pole, but the pole of greatest cold.

In the next place we may imagine that these currents, as far as regards a particular place, have a daily oscillation. This has, I believe, been proved as regards the lower-currents or trade-winds, which are more powerful during the day than during the night, and we may therefore expect it to hold good with regard to the upper-currents or anti-trades; in fact, we cannot go wrong in supposing that they also, as regards any particular place, exhibit a daily variation in the intensity with which they blow.

Again, we are aware that the earth is a magnet. Let us not now concern ourselves about the origin of its magnetism, but rather let us take it as it is. We must next bear in mind that rarefied air is a good conductor of electricity; indeed, according to recent experiments, an extremely good conductor. The return-trades that pass above from the hotter equatorial regions to the poles of cold, consisting of moist rarefied air, are therefore to be regarded in the light of good conduct-

ors crossing lines of magnetic force; we may therefore expect them to be the vehicle of electric currents. Such electric currents will of course react on the magnetism of the earth. Now, since the velocity of these upper-currents has a daily variation, their influence, as exhibited at any place upon the magnetism of the earth, may be expected to have a daily variation also.

The question thus arises, Have we possibly here a cause which may account for the well-known daily magnetic variation? Are the peculiarities of this variation such as to correspond to those which might be expected to belong to such electric currents? I think it may be said that, as far as we can judge, there is a likeness of this kind between the peculiarities of these two things, but a more prolonged scrutiny will of course be essential before we can be absolutely certain that such currents are fitted to produce the daily variation of the earth's magnetism.

Besides the daily and yearly periodic changes in these upper convection-currents we should also expect occasional and abrupt changes forming the counterparts of those disturbances in the lower strata with which we are familiar. And these may be expected in like manner to produce non-periodic occasional disturbances of the magnetism of the earth. Now, it is well known that such disturbances do occur; and, further, that they are most frequent in those years when cyclones are most frequent; that is to say, in years of maximum sun-spots. In one word, it appears to be a tenable hypothesis to attribute at least the most prominent magnetic changes to atmospheric motions taking place in the upper regions of the atmosphere where each moving stratum of air becomes a conductor moving across lines of magnetic force; and it was Sir William Thomson, I believe, who first suggested that the motion of conductors across the lines of the earth's magnetic force must be taken into account in any attempted explanation of terrestrial magnetism.

It thus seems possible that the excessive magnetic disturbances which take place in years of maximum sun-spots may not be directly caused by any solar action, but may rather be due to the excessive meteorological disturbances which are likewise characteristic of such years. On the other hand, that magnetic and meteorological influence which Mr. Broun has found to be connected with the sun's rotation points to some unknown direct effect produced by our luminary, even if we imagine that the magnetic part of it is caused by the meteorological. Mr. Broun is of opinion that this effect of the sun does not depend upon the amount of spots on his surface.

In the next place, that influence of the sun, in virtue of which we have most cyclones and greater meteorological disturbance in the years of maximum spots, cannot, I think (as far as we know at present), be attributed to a change in the heating power of the sun. We have, no doubt, traces of a temperature effect which appears to depend

upon the sun-period, but its amount is very small, whereas the variation in cyclonic disturbance is very great. We are thus tempted to associate this cyclone-producing influence of the sun with something different from his light and heat. As far, therefore, as we can judge, our luminary would appear to produce three distinct effects upon our globe. In the first place, a magnetic and meteorological effect, depending somehow upon his rotation; secondly, a cyclonic effect, depending somehow upon the disturbed state of his surface; and, lastly, the well-known light and heat effect with which we all are familiar.

If we now turn to the sun, we find that there are three distinct forms of motion which animate his surface-particles. In the first place, each particle is carried round by the rotation of our luminary. Secondly, each particle is influenced by the gigantic meteorological disturbances of the surface, in virtue of which it may acquire a velocity ranging as high as one hundred and thirty or one hundred and forty miles a second; and lastly, each particle, on account of its high temperature, is vibrating with extreme rapidity, and the energy of these vibrations communicated to us by means of the ethereal medium produces the well-known light and heat effect of the sun.

Now, is it philosophical to suppose that it is only the last of these three motions that influences our earth, while the other two produce absolutely no effect? On the contrary, we are, I think, compelled, by considerations connected with the theory of energy, to attribute an influence, whether great or small, to the first two as well as to the last.

We are thus led to suppose that the sun must influence the earth in three ways, one depending on his rotation, another on his meteorological disturbance, and a third by means of the vibrations of his surface-particles.

But we have already seen that, as a matter of fact, the sun does appear to influence the earth in three distinct ways—one magnetically and meteorologically, depending apparently on his period of rotation; a second cyclonically, depending apparently on the meteorological conditions of his surface; and a third, by means of his light and heat.

Is this merely a coincidence, or has it a meaning of its own? We cannot tell, but I may venture to think that, in the pursuit of this problem, we ought to be prepared at least to admit the possibility of a threefold influence of the sun.

Even from this very meagre sketch of one of the most interesting and important of physical problems, it cannot fail to appear that while a good deal has already been done, its progress in the future will very greatly depend on the completeness of the method and continuity of the observations by which it is pursued. We have here a field which is of importance not merely to one, or even to two, but almost to every conceivable branch of research.

Why should we not erect in it a sort of science-exchange, into

which the physicist, the chemist, and the geologist, may each carry the fruits of his research, receiving back in return some suggestion, some principle, or some other scientific commodity that will aid him in his own field? But to establish such a mart must be a national undertaking, and already several nations have acknowledged their obligations in this respect.

Already the German Government have established a Sonnenwarte, the mere building and equipment of which is to cost a large sum. With an appreciation of what the spectroscope has done for this inquiry, the first directorship was offered to Kirchhoff, and, on his declining it, Herr Vogel has been placed in charge. In France, also, a physical observatory is to be erected at Fontenay, on an equal, if not greater scale, of which Janssen has already accepted the directorship; while in Italy there are at least three observatories exclusively devoted to this branch of research. Nor must we forget that in this country the new observatory at Oxford has been so arranged that it can be employed in such inquiries. But what has England as a nation done?

Some years since, at the Norwich meeting of this Association, a movement was set on foot by Colonel Strange, which resulted in the appointment of a royal commission on the advancement of science, with the Duke of Devonshire as chairman. This commission have quite recently reported on the steps that ought in their opinion to be taken for the advancement of scientific research.

One of their recommendations is expressed in the following words:

"Important classes of phenomena relating to physical meteorology and to terrestrial and astronomical physics require observations of such a character that they cannot be advantageously carried on otherwise than under the direction of Government. Institutions for the study of such phenomena should be maintained by the Government; and, in particular, an observatory should be founded specially devoted to astronomical physics."

If the men of science of this country who procured the appointment of this commission, and who subsequently gave evidence before it, will now come forward to support its recommendations, it can hardly be doubted that these will be speedily carried into effect.

But other things besides observations are necessary, if we are to pursue with advantage this great physical problem.

One of these is the removal of the intolerable burden that has hitherto been laid upon private meteorologists and magneticians. Expected to furnish their tale of bricks, they have been left to find their own straw. Nothing more wretched can be imagined than the position of an amateur—that is to say, a man who pursues science for the love of it, and is unconnected with any establishment—who has set himself to promote observational inquiries, whether in meteorology or magnetism.

He has first to obtain with great expenditure of time or money, or both, copies of the individual observations taken at some recognized institution. He has next to reduce these in the way that suits his inquiry; an operation again consuming time and demanding means. Let us suppose all this to be successfully accomplished, and a valuable result obtained. It is doubtless embodied in the transactions of some society, but it excites little enthusiasm, for it consists of something which cannot be repeated by every one for himself like a new and interesting experiment. Yet the position of such men has recently been improved. Several observatories and other institutions now publish their individual observations; this is done by our Meteorological Office, while Dr. Bergsma, Dr. Neumayer, and Mr. Broun, are recent examples of magneticians who have adopted this plan. The publication of the work of the latter is due to the enlightened patronage of the Rajah of Travancore, who has thus placed himself in front of the princes of India, and given them an example which it is to be hoped they will follow. But this is only one step in the right direction; another must consist in subsidizing private meteorologists and magneticians in order to enable them to obtain the aid of computers in reducing the observations with which they have been furnished. The man of science would thus be able to devote his knowledge, derived from long study, to the methods by which results and the laws regulating them are to be obtained; he could be the architect and builder of a scientific structure without being forced to waste his energies on the work of a hodman.

Another hindrance consists in our deficient knowledge as to what observations of value in magnetism and meteorology have already been made. We ought to have an exhaustive catalogue of all that has been done in this respect in our globe, and of the conditions under which the various observations will be accessible to outside inquirers. A catalogue of this kind has been framed by a committee of this Association, but it is confined to the dominions of England, and requires to be supplemented by a list of that which has been done abroad.

A third drawback is the insufficient nature of the present facilities for the invention and improvement of instruments, and for their verification.

We have, no doubt, advanced greatly in the construction of instruments, especially in those which are self-recording. The names of Brooke, Robinson, Welsh, Osler, and Beckley, will occur to us all as improvers of our instruments of observation. Sir W. Thomson has likewise adapted his electrometer to the wants of meteorology. Dr. Roscoe has given us a self-recording actinometer, but a good instrument for observing the sun's heat is still a desideratum. It ought likewise to be borne in mind that the standard mercurial thermometer is by no means a perfect instrument.

In conclusion, it cannot be doubted that a great generalization is

looming in the distance—a mighty law we cannot yet tell what, that will reach us, we cannot yet say when. It will involve facts hitherto inexplicable, facts that are scarcely received as such because they appear opposed to our present knowledge of their causes. It is not possible perhaps to hasten the arrival of this generalization beyond a certain point; but we ought not to forget that we *can* hasten it, and that it is our duty to do so. It depends much on ourselves, our resolution, our earnestness; on the scientific policy we adopt, as well as on the power we may have to devote ourselves to special investigations, whether such an advent shall be realized in our day and generation, or whether it shall be indefinitely postponed. If governments would understand the ultimate *material* advantages of every step forward in science, however inapplicable each may appear for the moment to the wants or pleasures of ordinary life, they would find reasons patent to the meanest capacities for bringing the wealth of mind, now lost on the drudgery of common labors, to bear on the search for those wondrous laws which govern every movement, not only of the mighty masses of our system, but of every atom distributed throughout space.—*Nature.*

SUICIDE IN LARGE CITIES.

By ALLAN McLANE HAMILTON, M. D.

THE increased importance attached to the study of the relations of mind and body (the impetus to such study we have to thank Mr. Maudsley for) enables us to pursue our examination of certain psychical states to greater advantage than in former years. The investigation of suicide is now made much more clear as regards both the motive, behavior, and characteristics of the individual who takes his own life, and by the antecedents of his previous health, and other physical influences.

The object of this paper is to discuss the prevalence of this crime in large cities, its causes both moral and physical, and certain sanitary conditions which affect them. My observations have been made for the most part in New York, the largest city of the continent, and, as the most cosmopolitan, it offers an interesting field for research. I have made comparisons between the statistics of London and Paris, and, although it is impossible to obtain the most recent records of these two cities, I think a few hints may be gained that will be of value in preventing its increase. Statistics do not give us definite information upon the questions of heredity, cerebral injuries, neuroses, or other valuable aid in drawing conclusions, so that many important links are left out of the chain.

In all large cities the number of suicides is governed, to a great

extent, by the habits, tastes, and moral culture of the people, and, back of this, by the national characteristics. For example, the French, notorious for their indifference to life, their general volatility, frequent political troubles, and exaggerated morbid sentimentality, are celebrated for the propensity to end life by their own hands.

Paris has been, and always will be, celebrated for the prevalence of this crime. The late Forbes Winslow, in his "Anatomy of Suicide," called particular attention to this national failing of the French. They pursue it as an agreeable mode of getting relief from their troubles, and, from the statesman, who blows his brains out to escape political disgrace, to the *grisette* of former days, who shut herself up with her little pan of charcoal, to seek oblivion from her ruin, the crime is a general one. Montesquieu, on the other hand, asserted that the English are notably a suicidal race, and that London, with its fogs and cheerlessness, is more of a city for suicides than Paris. Forbes Winslow denied this, and demonstrated that fogs had no influence whatever upon suicides; or, at least, that there were fewer suicides in foggy months than in more pleasant ones. Our own statistics substantiate this, as will be shown further on, and the months of April, May, June, July, and August, really the most pleasant of the year as regard sunshine, are those in which more people kill themselves.

The gravity and stolidity of the English people would rather show in their favor as regards this crime. In the year 1810 the number of suicides in London amounted to 188. Comparison with French statistics of the same year proved that five times as many Parisians as Londoners took this means for ending their days. French statistics show the excessive mortality from this cause. In the year 1806, 60 suicides were reported in Rouen, an extremely small city; in 1793, 1,300 in Versailles. Paris, from 1827 to 1830, furnished 6,900 suicides, an average of nearly 1.8 per year. In recent years, we have better statistical returns to work upon.

In the year 1858 the population of London was 2,720,607, and the number of suicides 283. The youngest of these was ten years, and the oldest eighty-five. In Paris, in 1853, the population was 1,053,262. There were 463 suicides, an immense number in excess of London several years later. In Turin, from 1855 to 1859, there were 108 suicides, making an average of 21 a year. In Rome, in 1871, there were only 15 suicides, showing that self-murder is very uncommon among the Italians. In the city of New York, between the years 1866 and 1872, there were 678 suicides, being an increase of 100 in the last year over the first; 511 males, 167 females. For the three years, 1870, 1871, and 1872, there were 359 suicides, 132 being Germans, a very large percentage. As regards matrimonial condition during these years, I find there were 17 married persons, 118 single, 43 widows and widowers, and 27 whose condition was not stated: 275 were males and 84 were females; the age of the oldest was eighty-six, and that of the youngest ten.

The cause for the suicide of the latter was remarkable. She was detected in a theft of fifty cents, by her mother, and, to seek escape from her shame, took Paris-green. The months in which suicide was most prevalent were those of summer. In August, 1870, there were 15 suicides, while in December only 7. In June, the following year, there were 14, and July of 1872 shows 20, and December only 4.

In regard to occupation, clerks commit suicide the most frequently, about 34 in 1870, 1871, and 1872, and but 10 laborers in the same time. The percentage of laborers abroad is greater than any other. The mode of suicide most often employed in the city of New York is that of poisoning—212 out of nearly 600 persons have died from some form of poisoning. The preference seems to be for arsenic; usually its commonest form—Paris-green. In 1872, of 50 poisoning cases, 22 took Paris-green; the others chose either opium, carbolic acid, or other irritants. In 1871, 14 took Paris-green. Nearly all of the suicides chose violent and painful poisons, there being but few exceptions. One individual ended his days by hydrate of chloral; the other, a druggist, with prussic acid. Three took chloroform. Shooting ended the lives of 147 persons; 135 hung themselves. In only one or two instances was any ingenuity shown in the suicides: one of these individuals first shot himself, and then jumped out of the window; the other threw himself in front of an advancing locomotive. In London, hanging seems to have been the method most in vogue, for, in the year 1858, 56 persons perished in this way.

A. Brierre de Boismont, in his "Recherches Médico-Légale sur Suicide," Paris, 1859, collected 4,595 cases, carbonic-acid gas and drowning being the favorite modes for self-murder with men, and strangulation with women. Of 463 suicides occurring in the year 1853, 92 men perished by carbonic-acid gas, 93 by drowning, and 131 women died by strangulation. The more ancient statistics show that voluntary starvation was a common form of suicide in the beginning of this century. The motive for suicide in the reported cases was extremely difficult to discover. Of the 463 cases in Paris in 1853, insanity produced the suicide of 53 men, 37 women; drunkenness, 48 men, 14 women; misery and grief, 20 men, 8 women; disappointed love, 28 men, 20 women; shame, 18 men, 9 women; domestic trouble, 18 men, 15 women; weariness of life, 20 men, 7 women; disease, 27 men, 19 women; fear of the law, 16 men, 2 women; ill-luck, 23 men, 14 women; trouble with parents, 5 men, 5 women; loss of situation, 8 men; loss of parents, 1 woman. By this table, it will be seen that insanity causes the largest number of suicides, both of men and women; drunkenness comes next, and disease third.

In regard to the form of suicide with fire-arms, Boismont shows, by a carefully-arranged table, that the greatest number shoot themselves in the mouth, seventy-five per cent. choosing this means.

Out of 368 cases, 234 shot themselves in the mouth, 71 in the ab-

domen and thorax, 26 in the temple, and but 1 in the ear, thus showing a knowledge of the vital parts of the body. In illustration of the coolness and resolution of these suicides, he found that 85 left wills. The chirography of letters and various communications written before death was steady and natural, not betraying any signs of weakness, trembling, or irresolution on the part of the writers. Parisian statistics prove that of 3,518 cases, 2,094 occurred in the daytime, 766 in the evening, and 658 at night, proving that daylight is most agreeable for this kind of work. The ages at which suicide seems to be most often resorted to are between forty and fifty among the men, and forty-five and fifty-five among the women.

The greatest number of suicides in the city of New York, as I have said, are by poison, and this mode of self-destruction being the favorite one, we are naturally led to inquire why it should be so. When we take into consideration the looseness of our present laws regarding the sale of poisonous drugs, and the comparative ease by which suicides can procure the agents for their destruction, we have very little cause for wonderment. The number of cases of accidental death which have occurred through the criminal carelessness of certain druggists, who deal the most deadly drugs to persons unknown to them, is worthy of serious comment. There appears to be no difficulty for the would-be suicide to buy just what poison he desires. A large proportion of the inhabitants of great cities are confirmed in certain pernicious habits. Among them are opium-eating and chloroform-taking, which they pursue to what extent they choose, as these articles are always to be had.

It is needless to say that the opium-habit, like alcoholism, frequently leads to self-destruction.

In this country, upon several occasions, certain individuals have taken their own lives after insuring them, that the policy might be paid to the family of the suicide. This is an example of a very interesting psychical condition. Alcohol and its secondary effects have swelled the number of suicides, and the victims who have died by their own hands have been equally of the higher and the lower classes in this country. I think a great increase in the returns of mortality of this especial variety of suicide would be observed if the reporting physicians would conscientiously state the cause of death. The shame attached to the procedure, particularly among people of position, has prompted the return to be made of "meningitis," "cerebral congestion," or other diseases. Within the last two years, I can call to my mind the suicide of six people of high social position, caused by drink. This vice is perhaps not entirely characteristic of large towns, but the facility for indulgence of the habit, and the numerous ways of drinking in private, are more perfect in the cities.

In smaller places, there is a certain amount of contact with one's fellows, which makes him the cynosure of all eyes, should he indulge

too freely. As I have before said, the busy life men lead in the metropolis, and the necessity for brain-stimulus, accelerate the *facilis descensus*. The disgrace of men in high position, impending ruin and other facts, will often prompt suicide as a mode of relief.

A form of suicide which figures largely in American statistics is, jumping from an elevation. This may be chosen by the individual as an effectual method, if he hesitates to select one, or may be the result of a momentary state of delirium produced by the surroundings. This latter is a common form in some European cities that contain high churches, monuments, or towers. I have myself experienced a morbid desire of this character, after an ascent of the Mountain Corcovado, in the harbor of Rio de Janeiro. When looking over a steep precipice upon this bay, two thousand or more feet below, I felt a strange restlessness and distention of the blood-vessels, with an irresistible desire to leap out into the clear air. This disappeared when I looked upon some object near by. A medical friend relates a case in his own experience. He went with an acquaintance up into a very high, unfinished public building. There was no evidence of insanity in his acquaintance. When my friend's back was turned, his companion jumped far out into the air, and fell mangled to the sidewalk. In France this form of suicide is a very common one, 45 individuals in the year 1820 having precipitated themselves from heights. In the year 1852, 16 men and 19 women chose this means of self-murder. So prevalent were those suicides, that the authorities refused admission to the Column Vendôme. As I have before said, this method is not an unusual one. In New York, between the years 1866 and 1872, there were 21 victims.

Dr. C. P. Russell, of New York, has informed me of a friend who is to such an extent the subject of the impulse to throw himself from heights, that he will never sleep upon the third or fourth floor of any dwelling.

The impulse to commit suicide with sharp-cutting instruments has been more common in the European cities than those of this country, and, in the majority of instances, suicide by these weapons has been resorted to by insane subjects.

A most important study in connection with this subject is the influence of the mode of life of the poorer classes. I allude more particularly to the tenement-house system—to the colonization of many thousand people in a limited space, much too small for them. They are brought together so, that every vice becomes, to a great degree, contagious. Bad examples are followed by the younger generation, and it is much easier for a seed of sin to take root here than one of virtue. Families of several nationalities are closely packed together in front and rear houses. Ground and labor are so expensive, in the larger cities particularly, that this mode of living is unavoidable.

Despite the earnest efforts of an efficient health board in the city

of New York, many radical defects exist, and ventilation, light, and drainage, are defective in the extreme. Diseases of the nervous system, principally of the trophic character, exist to a great extent, as results of imperfect lighting and ventilating.

In the five years preceding 1872 the deaths from nervous diseases in New York averaged 3,155.8, and for the years 1871 and 1872 were over 6,000, an unusually large proportion, the number of deaths from all causes being 59,623. The vices attending the colonization of the working-class (a great many do not work) are contagious, the moral contact of the vicious with the pure is certain to occur, the ruin of young girls, and depression of tone, are powerful inducers of suicide.

The American people partake of the characteristics of their transatlantic brethren. They are impulsive, energetic, enterprising, emotional, liable to excessive mental depression or exaltation. We have all the different bloods of Europe in our veins. We lead, however, an individual life of our own, a life as original and striking as other startling peculiarities of our country. We live too fast; we make and lose fortunes in a day; we acquire professional educations in a few years which take ordinary individuals as many more to get the rudiments of in Europe. It is any thing but *festina lente* here. The seeds of every national soil are sown, and take root before we can employ measures to suppress them. Every thing that can excite the emotions, make tense the mental faculties, and suddenly relax them, is among us. Speculations and stupendous schemes, which in older countries take several heads instead of one to mature, crush down the nervous system of men who work themselves to death, hardly taking time to eat, meanwhile living upon stimulants to enable them to stand the strain.

There is another class—I allude to the poor. The newspaper accounts of the miserable suicide in his upper attic tell this story every day. These subjects are chiefly foreigners, deluded to this country by unfounded expectations of fortunes to be made.

Only a few days ago I read in one of the daily papers that it was not an uncommon occurrence for immigrants to ask of the officials at Castle Garden, in perfect good faith, positions as insurance officers, bank officers, and other unattainable positions.

Many thousand Italians were sent here by rascally agents in their own country several years ago. They were promised work by these individuals, but on their arrival found none. They reached New York in mid-winter, and many of them found their way into the workshops and almshouses. Misery and suffering were prevalent. Among immigrants, particularly the Germans, there is a great disposition to suicide, and physical suffering doubtless awakens any hereditary tendency that may lie dormant. A great percentage remain at the seaport, looking for work. New York is particularly affected in this way. Immigrants come here, probably in most instances from occupations

much more steady and remunerative in comparison to any found here; tradespeople, skilled workmen, and mechanics, often commit suicide, who find it difficult to obtain employment, and finally hunger and disappointment drive them to this step.

The prevalence of strikes, and trades-unions, with their dangerous restrictions and foolish oaths of allegiance, are fruitful causes of suicide. Men are afraid to work in opposition to the threats of their fellow trades-unionists, and, as poverty stares them in the face and they become desperate, they commit suicide.

A necessary attendant upon increase in population is immorality, engendered by vice attendant upon civilization. The more depraved forms of theatrical amusement found at the low theatre halls, two or three of which now exist in New York, wipe out all of the original purity from the nature of the weak-minded spectators. The low songs at some of these places, abounding in *double entendres* and suggestive gestures, inflame the dormant instincts of lust in the minds of the deeply-interested audience.

Prostitution is a very easy way leading to suicide. The attendant vices of this class very soon destroy the mind. Opium-eating, inebriety, and snuff-chewing, are habits which nearly all prostitutes follow after a time. The classification of these causes of suicide and their victims is very incomplete, and prostitution is placed on the records in only one instance in 1871, 1872, and 1873, as the calling of the individual.

The prevalence of seduction in large cities is perhaps greater among the lower classes—the workers in factories and shops. Indeed, the chance for this crime among the many thousand young girls and men who are herded together indiscriminately in the large tobacco, hoop-skirt, paper-box, and other factories of great cities, is often made use of. Suicide follows ruin, though not in as many cases as it would in France. I do not doubt but that the large rivers, upon which most American cities are built, give up a great many bodies of unfortunates who end their moral ruin by suicide. In fact, the number of cases reported as "found drowned" may be assumed in general to be suicidal.

In our own cities, as I have before shown, clerks seem to be the class that most often take their own lives. This seems reasonable when we consider the peculiar careers of a great many of them—the temptations of vice, the struggles for situation and support, and the pitfalls of a large city.

How shall we prevent the increase of this crime which advances at the rate of 300 per cent. in seven years? What sanitary measures can be taken to defeat its moral and physical causes?

It is a stupendous undertaking. To reduce its statistics would require an attack upon our whole social system.

I have pointed out the rapidity of our way of living, the excessive

and unnatural strain upon the brains of business and professional men. To diminish this would be an almost impossible task. I can only suggest a diminution of working hours, the necessity for regular meals and habits, and means to prevent large cities from being overstocked by the agricultural classes, who imagine themselves in these days particularly fitted for business and professional pursuits. We should abolish immoral entertainments, advertising quacks, so-called anatomical museums, and obscene and sensational literature, as far as possible.

Legislation should strictly regulate the sale of poisonous drugs, and the police should enforce the laws. Friends and relatives of excitable and nervous persons should be alive to the necessity of keeping from their reach razors, cutting instruments, and poisons. They should also endeavor, as far as possible, to prevent the formation of the opium-habit, self-administration of chloroform, and alcoholic indulgence.

Careful watch should be kept on all persons who go up into high public buildings, church-spires, and other eminences. Physicians should employ caution lest their patients should habitually indulge in some narcotic drug originally prescribed. The boards of health of the different cities cannot be over-zealous in suggesting means for the improvement of the dwellings of the poor. Air, light, and ventilation, should be provided, if possible, for these are absolutely necessary for nervous development and healthy cerebration. I have always considered the system of small dwellings, that has succeeded so well in Philadelphia and other cities, an inestimable boon to the working-classes. A healthier moral and physical tone is engendered, both by elevating the self-reliance of heads of families, and the abolition of moral contamination so prevalent in tenement-house life.

The establishment of bureaus and other agencies for procuring work for immigrants, freeing the cities from the surplus of these people, would prevent much desperation, misery, and self-destruction.

A HOME-MADE MICROSCOPE.

By JOHN MICHELS.

THE progress of science in recent times is in a great degree due to the employment of instrumental aids to observation; and whoever wishes to keep up with this advance, or indeed to gain an adequate notion of its extent and interest, can only do so by the use of similar means. In the study of chemistry, experiments and actual observation of the behavior of substances under various conditions, are indispensable; in physics, multifarious appliances for the illustration of principles are constantly required; in astronomy,

the telescope is absolutely essential; and, in biology, vast departments can be brought within our reach only by the aid of the microscope. This latter instrument, especially, has a wide range of application. The investigations of the anatomist and physiologist cannot go on without it; the educated physician has it in daily use; the tradesman finds it an important aid in testing the purity of commodities; and the student in many departments of physical science is obliged to use it in his work. When to all these considerations we add that the manipulation of the microscope, for the purpose of ordinary observation, may be acquired without much difficulty, and that the instrument itself may be procured at a moderate cost, we have said enough to justify the assertion that every educated person ought to possess a microscope, even as he possesses a collection of books.

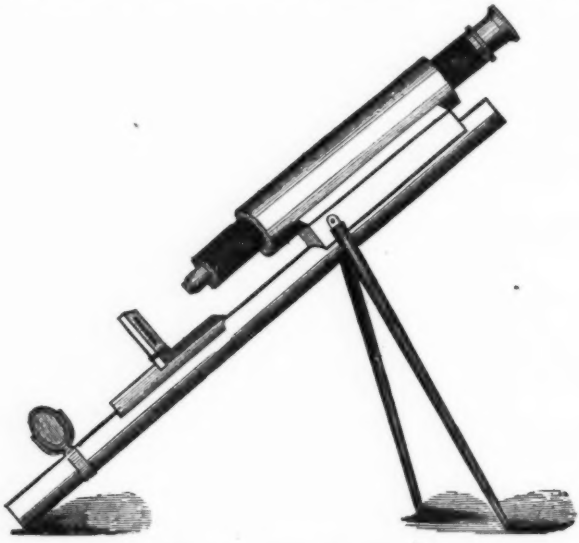


FIG. 1.—COMPLETE INSTRUMENT.

To derive advantage from the use of the microscope, it is not necessary that one should master all the technicalities of the instrument, or be possessed of all the improved appliances for extremely minute observations. Professional microscopists have recognized the error of directing all one's efforts on such tasks as the resolution of test-plates, so long as really urgent work remains undone. Thus, the President of the "Quekett Microscopical Society" remarked:

"Our opticians have gone ahead of the observers, they have placed in our hands powerful means of research. I fear the account of the talent committed to our charge will not be one of which we may be proud. I fear we are too apt to pride ourselves as being the possessors of superior instruments; each man pits his instrument in rivalry against his neighbor's, and rejoices that he can beat him in the resolution of Nobert's test-plate."

Mr. Le Neeve Forster, in the above remarks, doubtless strikes at the root of an evil that is fast becoming a nuisance, to the utter detriment of useful and sound work; the test-slide and diatom fever has spread like an infection among all classes of microscopists, and has resulted in an extravagant system of expenditure foreign to true scientific research. I find that $1,650 is now asked for a first-class instrument and fittings, and as much as $40 apiece for diatom-slides.

These eccentricities of leading microscopists appear to have received protests from various quarters, for the President of the Royal Microscopical Society, in his last address, states:

"It has been cast at us, as Fellows of this Society, that we do nothing but improve our tools, or measure the markings on the frustules of a diatom." [1]

One reason for the confessed poverty of microscopical results may be ascribed to the want of sufficient workers to cover so vast a field of research. It is to be regretted that many professional men, whose occupation would seem to demand the daily use of the microscope, deny themselves the facilities it offers. I apprehend that the explanation of this apparent neglect will be found in the high price asked for first-class instruments, and the absence in the market of a good standard instrument that combines the advantages of being of the best workmanship, full-sized, portable in form, and moderate in price.

Messrs. Baker, Crouch, Collins, and especially Swift, all of London, produce such microscopes, but, as their importation doubles the cost, their chief merit of cheapness is lost. In our own country, opticians have proved that they can produce work that cannot be surpassed, provided that their patrons entertain the same views as Sir Charles Surface respecting the expense; but those of more moderate means, who wish to purchase a good working microscope at a moderate cost, are offered a pretentious display of foreign and domestic forms, totally unfit for professional or scientific use. If makers of microscopes would take a lesson from the best telescope-makers, and, instead of multiplying the number of their models, combine their energy in the production of a good standard instrument, filling the conditions that I have already stated, they would promote the cause of science and concentrate their business.

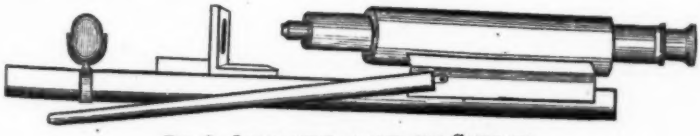


FIG. 2.—INSTRUMENT FOLDED FOR CARRIAGE.

Those who have read the biographical and obituary sketches of eminent microscopists have probably noticed that it was a favorite pursuit with many of them to make their own instruments. In the

[1] February 3, 1875.

Monthly Microscopical Journal, for March last, will be found such a notice included in the address of the President of the Royal Microscopical Society, referring to the death of a Fellow, Mr. John Williams, who was also Assistant Secretary of the Royal Astronomical Society. He said:

"He constructed more than one microscope out of odds and ends, which he put together with much skill and ingenuity. His most elaborate microscope was made with cardboard tubes and brass-screw adjustments. This instrument, when supplied with objectives by Ross and others, contrasted favorably, in point of utility, with constructions of a more costly character."

The perusal of this notice, followed by a communication to the effect that in some of the London scientific schools the students are required (when practicable) to make all the apparatus they use, has prompted me to describe a microscope made by myself about six years ago, and which is now but little the worse for wear.

So far as the stand is concerned, it can be easily made at home, at a trifling cost. The materials are of a humble character, but the optical arrangements are full-sized, and of the highest quality. Within the limits of its use this instrument will exhibit objects with much perfection. By a reference to the cuts, it will be observed that many of the parts are cylindrical, and may be turned on any ordinary lathe in a few minutes.

To make a microscope such as I shall now describe, requires little mechanical skill. If my directions are followed, and strict attention given to the drawings, no difficulty will be encountered, but neatness and precision are of course essential. First provide a wood rod about 15 inches long, and of the circumference of Fig. 3.

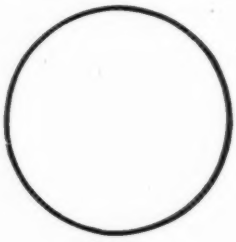


FIG. 3.

FIG. 4.

Then take some paper of firm texture, and wind it around the rod three or four times according to its thickness, applying mucilage all the time; immediately withdraw the paper casing, and place on one side to dry. This should form a perfectly true and firm tube. When dry, replace it on the rod, and with a sharp knife cut off from each end sufficient to leave the remainder 7½ inches long.

The other parts are of wood. I suggest mahogany as the most appropriate, and susceptible of the best finish; but any well-seasoned, hard wood will do.

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To proceed, make a rod, like an ordinary ruler, 13½ inches long, and of the diameter of Fig. 4. Now turn, or get turned, a tube, 4½ inches long, the walls of which shall be ¼ of an inch thick; Fig. 5 will give the diameter.

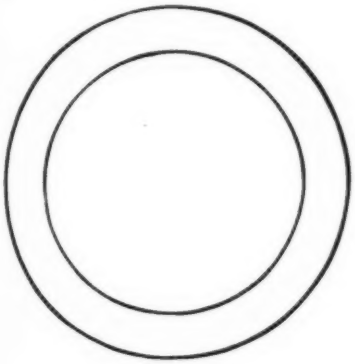


FIG. 5.

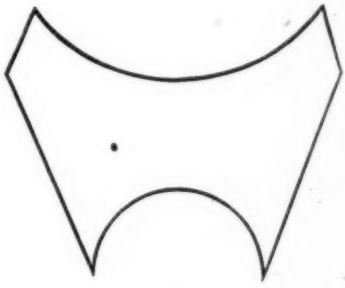


FIG. 6.

A part which I call the cradle can now be made; the form is shown in section, at Fig. 6; its length must be 3¾ inches.

The support for the stage requires no special explanation; a full-sized drawing is given at Fig. 7.

The stage itself can be made of wood, but gutta-percha is better,

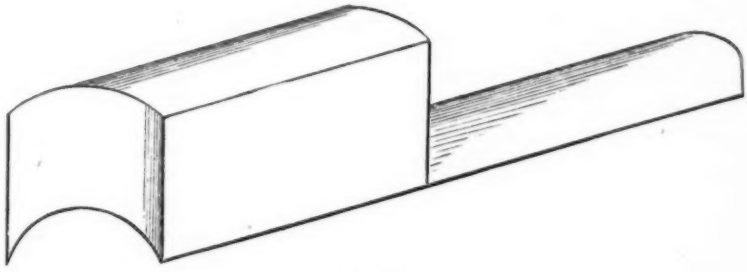


FIG. 7.

and, if placed in hot water, it can afterward be easily moulded to the pattern given at Fig. 9.

Smooth the surface while still warm with glass plates, and steady the back with two strips of wood. The shaded part at the lower edge shows a piece of wood fixed thereon to support a zoöphite trough or glass slides. Fig. 10 represents the upper and lower parts of a leg, two of which are required, 9¾ inches long, and the size shown in cut. On the upper portion the brass hinged attachment is fixed.

The appearance of the paper tube, with eye-piece and object-glass in position, can be seen at Fig. 11.

The parts which have been already described being completed, proceed to fix them together with glue. Their correct position can be seen at a glance by reference to Fig. 12.

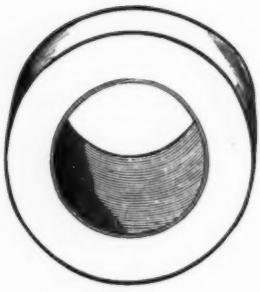


FIG. 8.

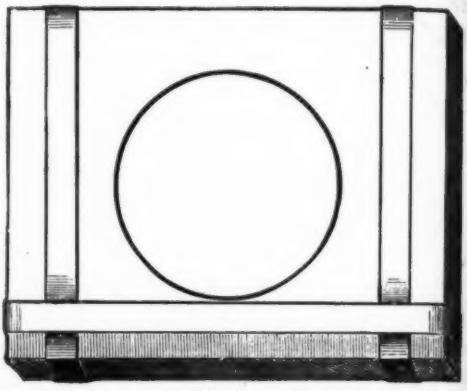


FIG. 9.

First fix the cradle, 6, upon the rod, 4—within three-quarters of an inch of the end—next the tube, 5, upon the cradle, as shown. The stage and support can next be fastened, but first insert the paper tube, Fig. 11, in wooden tube, 5, and measure the most convenient

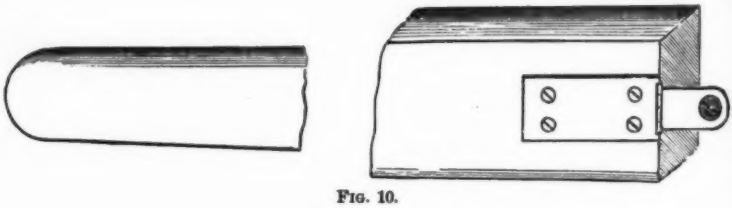


FIG. 10.

place to fix the stage, so that the object-glass can approach the object without bringing the tube too low down. A trial will at once fix the proper spot.

The legs are attached by screws to the cradle, as seen in Figs. 1 and 2. The whole being now in form, clean and French-polish.

FIG. 11.

Also paint the inside of the paper tube a dull black, using drop-black, turpentine, and a little Japan varnish to fix color, and the outside with a mixture of Indian and common inks. Finally, line tube, 5, with a piece of fine cloth. If this is neatly done, the paper tube,

Fig. 11, will pass and repass as smoothly as the motion of a telescope, which is controlled in a similar manner.

There is no reason why the optical parts should not be made by the student, but necessary instructions would require a series of articles. Assuming, therefore, that such portions will be purchased, a few words on that head may be necessary.

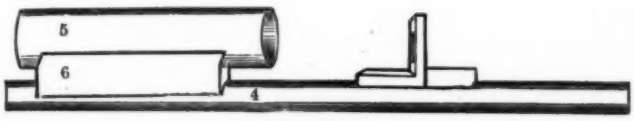


Fig. 12.

If only one eye-piece is required, select letter B. Next take tube, Fig. 11, to an optician, and ask him to fit a Royal Microscopical Society screw, Fig. 8, in the centre of a wood block. This block and screw must be fastened into one end of the paper tube, and will carry the object-glass.

The last fitting will be the mirror, a reduced drawing of which is shown at Fig. 13.

The mirror should be at least two inches in diameter, and the ring which passes over the rod, Fig. 4, should be split, and about half an inch in breadth, and, being made somewhat too small, will grip the rod, and be free from unsteady movement.

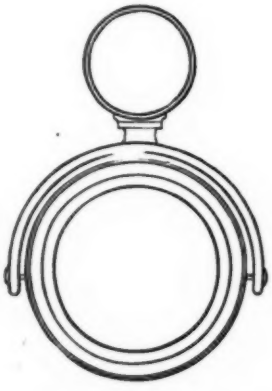


Fig. 13.

To hold the slide upon the stage in position, pass two moderate-sized India-rubber bands upon each side, and a third crosswise near the bottom; a very delicate movement can be given to a slide thus held.

In regard to object-glasses I have little to add. Such as I should have specially recommended are not to be obtained in this country;

but, to commence operations with, purchase the best 1-inch and ½-inch your means will permit. I much regret that the objectives made by Gundlach, of Berlin, are not introduced. It would be a boon to those who cannot afford to purchase the best glasses. I have seen them tested at the Royal Microscopical Society with the most costly objectives, where their performance has elicited the highest praise. When I state that an immersion $\frac{1}{16}$ costs in London but £3 10*s*., the price of the low powers can be calculated.

These $\frac{1}{16}$ths have wonderful definition, and can be used upon all slides, having the ordinary thin glass cover, a great advantage. Such a glass could be sold here for thirty dollars, and the 1-inch and ½-inch for about ten dollars apiece. Except for special work, these objectives answer every purpose. The sketch at Fig. 1 is a correct drawing of the complete instrument, in position for use; and at Fig. 2, the same folded, showing its convenience and portability. The whole weighs about a pound, and can be carried, with eye-piece and object-glass ready for use, either in a bag or a light box $14 \times 3\frac{1}{2} \times 3$ inches.

Those who possess very large instruments will find this model a most useful addition for occasional use when traveling or demonstrating subjects away from home.

This form of microscope is offered as convenient for beginners, who, unable to purchase a complete instrument, still wish to make a beginning and start upon a right principle. Although a complete microscope can be purchased for about the same amount that the optical portions of this will cost, it will be wanting in the chief essentials of a good working instrument. Diminutive size, smallness of field, poor light, shortness of tube, absence of Society's screw, and other evils, will soon cause it to be cast aside, resulting in the loss of the original outlay; whereas the parts purchased under the above directions are portions of a first-class instrument, obtained in advance, which will never become obsolete.

The immense field of inquiry within the grasp of the microscopist is apt to disconcert and confuse the student. His course, however, should be well defined. First let him familiarize himself with what has been done by others, and then confine his attention strictly to those subjects which have reference to his profession or pursuit. If he has no special occupation, I would advise him to select a particular line of study, and let that be the thread on which to string his subsidiary matter, mounting his own objects, and carefully registering his observations. He will thus slowly but surely accumulate knowledge that will benefit the cause of science.

IS ALCOHOL A FOOD?

CORN and wine were deemed indispensable to man from the remotest antiquity, just as beef and beer are so considered by the Briton; and scarcely a people has existed who did not possess a fermented liquor of some kind—all ascribing to it exalted virtue, such as befits the gift of the gods, as all believed it to be—not only from the bodily comfort and invigoration which it imparted, but also from its mysterious effects in the transient madness which it is capable of producing. Among all nations, consequently, wine, or alcoholic drinks of some sort, has always had its poets or its minstrels; and, had the ancients been acquainted with alcohol, or the essential product of fermentation as *we* know it, doubtless they would have made it the symbol of the soul, for which nothing could be more appropriate; for it is an *invisible power*, hidden in a grosser body, which it influences in every part, and from which it finally escapes into the "heaven above"—gone forever! Nor is that all. The analogy may be extended to the *qualities* of that image of the soul, which are good and bad united, as in other mystic unions. Had the ancients possessed this knowledge of the distinct yet intimately combining principle, it might have given more significance to their devotion when they poured libations to their gods—but how much greater would have been their sense of awe and wonder, had they known what the physiologist knows at the present day! Let us glance at this truly mysterious agent in action.

Alcohol is ever ready to enter the animal system. It can be introduced under the skin or into a vein. Exalted by heat into the form of vapor, it may be inhaled by man or other animal, when it will penetrate into the lungs, will diffuse itself through the bronchial tubes, will pass into the minute air-vesicles of the lungs, will travel through the minute circulation with the blood that is going over the air-vesicles to the heart, will condense in that blood, will go direct to the left side of the heart, thence into the arterial canals, and so throughout the entire body.

Again, when taken in by the more ordinary channel, the stomach, it finds its way by two routes into the circulation. A certain portion of it—the greater portion of it—is absorbed direct by the veins of the alimentary surface, finds its way straight into the larger veins, which lead up to the heart, and onward with the course of the blood. Another portion is picked up by small structures proceeding from below the mucous surface of the stomach, and from which originate a series of fine tubes that reach at last the lower portion of a common tube, termed the thoracic duct—a tube which ascends in front of the spinal column, and terminates at the junction of two large veins on the left side of the body, at a point where the venous blood, returning

from the left arm, joins with the returning blood from the left side of the head on its way to the heart. It is so greedy for water that it will pick it up from all the watery textures of the body, and deprive them of it, until, by its saturation, it can take up no more, its power of reception being exhausted; after which it diffuses itself into the current of circulating fluid. When we dilute alcohol with water before drinking it, we quicken its absorption; and, if we do not dilute it sufficiently, it is diluted in the stomach by the transudation of water in the stomach, until the required reduction for its absorption is effected.

Now, after an investigation of a very elaborate character, Dr. Anstie and Drs. Thudichum and Dupré have satisfactorily proved that only a very small portion of the spirit which is taken into a living body is expelled out of that body as alcohol, in the secretions, and that there must be some other means by which the spirit is disposed of in the system. In one very remarkable and memorable experiment, Dr. Anstie gave a dog, weighing ten pounds, the liberal dose of two thousand grains of alcohol in ten days, and, on the last day of the ten, he administered ninety-five grains of the spirit as a final dose, and then two hours afterward killed the dog, and immediately subjected the whole body—blood, secretion, flesh, membranes, brain and bone—to rigorous analysis, and he found in the whole texture of the body only about 23½ grains of spirit. The other 1,976 grains had clearly, therefore, been turned into something else, within the living system.

These experiments directly refer to our query—the settlement of the food-power of alcohol as a doctrine of physiological science.

Before reasoning out this proposition, we must state certain facts which it seems impossible to reconcile with any other theory than that alcohol is a food. Dr. Anstie relates the case of an old soldier who was under his care at the Westminster Hospital in 1861, who had lived for twenty years upon a diet composed of a bottle of unsweetened gin and "one small finger-length of toasted bread" per day and who maintained the structures of his body for this long period upon that very remarkable regimen. Similarly an old Roman soldier admired by the Emperor Augustus, when asked how he managed to keep up such a splendid development, replied—*Intùs vino, extùs oleo*—"With wine within, and oil without."

Dr. Robert D'Lalor tells us that some thirty years ago, in foreign climes and in unhealthy districts, he lived for two years upon wine and brandy, with very little solid food; and at the end of the period was neither perceptibly poisoned, starved, nor emaciated. Laborers, navvies, coal-heavers, and others, who take no beer, eat nearly as much again as those who take a moderate allowance of beer. Dr. D'Lalor declares that he knows many vigorous and healthy men in London, not only waiters, potmen, publicans, and the like, but tradesmen and merchants, who eat but little solid food, but have plenty of wine, porter, gin, etc.

Liebig stated that, in temperance families where beer was withheld and money given in compensation, it was soon found that the monthly consumption of bread was so strikingly increased that the beer was twice paid for—once in money, and a second time in bread. He also reported the experience of the landlord of the Hôtel de Russie, at Frankfort, during the Peace Congress; the members of the Congress were mostly teetotalers, and a regular deficiency was observed every day in certain dishes, especially in farinaceous dishes, pudding, etc. So unheard of a deficiency, in an establishment where for years the amount of dishes for a given number of persons had so well been known, excited the landlord's astonishment. It was found that the men made up in pudding what they neglected in wine. Finally, every one knows how little the drunkard eats.

Again, in cases of disease, there are numerous instances which it is difficult to refer to any thing but the food-property of alcohol. Dr. Anstie refers to one very instructive case of the kind, which also came under his care in 1861, and which obviously left a great impression upon his mind. A young man, only eighteen years of age, was so reduced by a severe attack of acute rheumatism, that he was unable to retain food of any kind upon his stomach. He was sustained for several days upon an allowance of twelve ounces of water and twelve ounces (¾ pint) of gin per day. His recovery under this treatment was very rapid and complete, and almost without any trace of the emaciation and wasting that ordinarily follow upon such a disease. The lad, previous to this illness, was of a strictly sober and temperate habit, and, during the use of gin, the abnormal frequency of the pulse and of the breathing came gradually down to the proper standard of ordinary health; and there was never at any time the slightest tendency to *intoxication*—which is a very notable point in such cases.

Dr. D'Lalor, before quoted, also mentions the case of a child only fourteen months old, suffering from inflammation of the lungs, and whose stomach could retain nothing but port wine. For twelve days it subsisted entirely upon wine; it was rapidly cured, with no wasting of any account; nor, although it drank large quantities of alcohol, was it ever intoxicated.

These cases are very important on account of their exceptional character; but they are quite in accordance with the well-established power of brandy and wine to sustain the life of sinking men in the critical periods of exhausting fevers; and they afford ground for the familiar and popular belief that there is support in wine and spirituous drink—as held of old and exemplified in the well-known recommendation of St. Paul to his ailing disciple.

Dr. Anstie's conclusion from such evidence, and from a very large hospital experience, is that, beyond all possibility of doubt, pure alcohol, with the addition of only a small quantity of water, will pro-

long life greatly beyond the period at which it would cease if no nourishment is given; that, during the progress of acute diseases, it very commonly supports not only life, but also the bulk of the body, during many days of abstinence from common foods; and that, although the physician and physiologist fail to explain chemically how it is that the result is brought about, it may, nevertheless, be safely affirmed that the influence exerted over the body by alcohol is, essentially, of a *food-character.*

"It may be well," observes a writer in the *Edinburgh Review*, "for even advanced and accomplished physiologists to bear in mind that there may be 'more things in heaven and earth than are dreamt of in their philosophy.' There would at least be nothing more startling in the discovery that the physiological dogma which affirms that the products of the reduction of complex organic substances (such as alcohol) cannot be employed as the food of animal life had to be *reconsidered*, and in some particulars reversed, or revised, than there has been in the recent reversal of the Liebig dogma, that *nitrogenous* principles alone can be used for constructive purposes, and the simpler hydrocarbons alone for the production of animal warmth."

And, in this point of view, Dr. Anstie argues that many substances which are ranked as even "poisonous" to the system must not be taken to be absolutely "foreign" to the organism, except in a relative sense, when even such agents as mercury and arsenic, given in small doses for long periods, produce what is termed a tonic influence, improving the quality of the blood and the tissues, and do this in such a way that it is scarcely possible to maintain that they contract no organic combination.

Dr. Anstie frequently dwells on the notable fact that in all cases of disease where alcohol is used successfully as a medicinal support—as in the case of exhaustive fevers—its presence as an alcoholic emanation, whether in the breath or in other secretions, is absent altogether, as if, in those cases, the whole force of the agent was absorbed in its beneficent operation. He also declares that in such instances its exciting and intoxicating powers appear to be in abeyance, and that the recovery from acute disease where this medicine has been successfully employed is invariably more rapid and complete than it is in altogether similar cases which have been treated without alcohol.

If alcohol be *only* a heat-producing food, it may be remarked that nowadays Liebig's well-known theory is no longer absolute, since it is established that great labor may be performed for a short period without the use of a nitrogenous diet—that is, with one exclusively carbonaceous. Hence, perhaps, the claim of alcohol to constitute a food. Although forming none of the constituents of blood, alcohol limits the combination of those constituents, and in this way it is equivalent to so much blood. As Moleschott says: "He who has little can give but little, if he wish to retain as much as one who is prodi-

gal of his wealth. Alcohol is the *savings-bank of the tissues.* He who eats little, and drinks alcohol in moderation, retains as much in his blood and tissues as he who eats more, and drinks no alcohol."

But, while we thus know that alcohol supplies the place of a certain quantity of food, we do not know how it does so. It is said to be "burnt" in the body, and to make its exit as carbonic acid and water; but no proof has yet been offered of this assertion. Some of it escapes in the breath, and in certain of the secretions; but how much escapes in this way, and what becomes of what remains—in the very large proportion, in the case of the dog previously mentioned—is at present a mystery.

In Steinmetz's "History of Tobacco," p. 97, occurs the following surmise, published nearly twenty years ago, but now established as a matter of fact. He says: "I feel compelled to believe, in advance of Liebig, that *alcohol is absolutely generated in the digestive process of all animals.* Startling as the theory may seem, the consideration of corroborating facts may, perhaps, induce the reader to think it probable, if not certain. It is well known that all the vegetables we eat contain starch; all the fruits contain sugar. Now, starch can easily be converted into sugar; the process of malting is a familiar instance. . . . The natural heat of the body is precisely adapted, in the healthy state, to effect a fermentation after having changed the starch into *sugar*, which last is constantly found in the blood. That alcohol has not been found seems to result simply from the fact that it must be sought in arterial blood, or blood which has not lost a portion of its carbon *in transitu*, through the lungs in the respiratory process."

Now, it happens that Dr. Dupré, in the course of his investigations, discovered that alcohol is found in small quantity in the excretions even of persons who do not touch fermented beverage in any form—that is, the healthy system of the teetotaller *brews, so to speak, a little drop for itself.* But, if this be the case, it would seem that we have enough already in the system, and therefore there can be no need of having recourse to the bottle or the tap for more, unless the system be a prey to disease. And this applies especially to those who live mostly on vegetable or farinaceous food, who, it may be remarked, are naturally less inclined to alcoholic drinks than those who use animal food—when it becomes particularly dangerous. So that, if the Alliance and the supporters of the Permissive Bill would succeed in their aim, they should convert us all into vegetarians. To drunkards who are anxious to reform, this is a most important consideration.

In conclusion, the most reliable opinion respecting alcoholic drinks appears to be, that the relation of their actions to food is such that, when *they are required* by the system, they cause a necessity for increased food; but, when not required, they lessen the necessity for food. Now, as Dr. Edward Smith emphatically remarks, the tendency of *all* food, but particularly of animal food, is precisely in the same

direction; so that the skin is drier after than before dinner, other things being equal. In like manner, the hands and feet, and the skin generally, become hot and dry after taking alcoholic drinks, and an intoxicated man in a state of perspiration would be an unheard-of phenomenon.

The direct tendency of alcohol is to diminish muscular power in a state of health, but indirectly it may have the contrary effect by improving the tone of the system through the appetite and digestion of food. In the state of body in which alcohol has reduced muscular contractibility, all the vital actions temporarily languish; and so far the action of alcohol is opposed to foods, and it is not a food.

While the food-action of beer and wine may be accounted for by their known nutritive ingredients, other than alcohol, which they contain, much difference of opinion exists as to the true action of alcohol itself, and the problem to be solved is, whether it acts physically or chemically. The known actions of alcohol in man are physical in their character, and so they are upon food immersed in alcohol, or alcohol-and-water, when it is hardened, and the process of digestion retarded.

If it has been shown that alcohol is capable of supporting a few persons, it is certain that it kills in its own way ten thousand persons a year in Russia, and fifty thousand in England; but its method of killing is slow, indirect, and by painful disease.

Finally, two things must always be borne in mind. First, we use alcohol not on account of its importance as a nutriment, but on account of its effects as a stimulant or relish; and secondly, the borderline between its use and abuse is so hard to be defined that it becomes a dangerous instrument even in the hands of the strong and wise, a murderous instrument in the hands of the foolish and weak.—*Food and Fuel Reformer.*

SKETCH OF DR. H. C. BASTIAN.

PROMINENT among the contemporaneous explorers of biological and physiological science, the investigation of which is so active in the present age, is the subject of this notice, who, though still a young man, has achieved an undoubted eminence in the departments of study to which he has devoted himself. Dr. Bastian has done a good deal of excellent scientific work in the medical field, and has gained the wide respect of the profession; but he is more generally known by his researches into the origin of life; and is the author of perhaps the ablest work that has yet appeared on the question of the generation of the lowest animate forms. The careful readers of THE POPULAR SCIENCE MONTHLY are quite aware that the subject of so-called "spontaneous generation" has latterly not only occupied the

increasing attention of scientific men, but has been pushed forward by an unprecedented refinement of experimental investigation. The researches recently carried out may have settled it, or they may not, as further determinations and verifications will show; but, whatever may be the fact on this point, the inquiry has certainly been remarkably narrowed, and the whole subject placed in a new attitude, which gives better promise of a decisive solution. Dr. Bastian, as is well understood, is a leading representative of the doctrine of the spontaneous origin of the lowest living forms. He has made an extensive series of delicate and ingenious experiments which, he holds, establish the principle, and which are freely admitted to give the problem a new aspect; and in his elaborate two-volumed work on the "Beginnings of Life," and his subsequent volume on "Evolution and the Origin of Life," he has given us the most comprehensive exposition we have of the philosophy and present position of this highly interesting and important question.

HENRY CHARLTON BASTIAN was born at Truro, in Cornwall, April 26, 1837. His father, a merchant, died while the son was quite young. He was educated at a private school in Falmouth; and, when about eighteen years of age, began the study of medicine with an uncle, who was a leading medical man of the town of Falmouth.

Young Bastian had already begun to acquire strong tastes for natural-history studies, principally in the direction of botany and marine zoölogy; these tastes having been much stimulated and encouraged by a retired London surgeon, Mr. W. P. Cocks, who had for some years energetically devoted himself to the fauna and flora of Falmouth and its neighborhood. Dr. Bastian recognizes a profound indebtedness to this gentleman for his influence in urging him to independent inquiry, inciting him to accept nothing on mere authority. During the three years of young Bastian's apprenticeship to his uncle, besides preparing for the matriculation examination of the University of London, he made a special study of botany, and in 1856 published "A Flora of Falmouth and Surrounding Parishes." His educational career was brilliant, and among the numerous university honors which he received may be mentioned the gold medal in botany; the gold medal in comparative anatomy; the gold medal in anatomy and physiology; the gold medal in pathological anatomy; and the gold medal in medical jurisprudence. He took his degree of M. D. in 1866, and became Fellow of the Royal Society in 1868. In 1860, Dr. Bastian became Assistant Curator of the Museum of Anatomy and Pathology under Prof. Sharpey. This office was retained for three years. In 1863, principally on account of his liking for cerebral physiology and philosophical subjects generally, he decided to devote himself to the study of insanity, with the view of becoming a consultant in London in this department of medicine. At the end of 1863 he went as assistant medical officer to the newly-opened State

Asylum for Criminal Lunatics at Broadmoor; and here for two years he carried on his investigations concerning the nematoids, which led to a monograph, in which one hundred new species were described. During this time and afterward, Dr. Bastian conducted an interesting and important series of investigations on the specific gravity of the brain. In 1866 he left Broadmoor, came to London, married, became lecturer on pathology and curator of the museum at St. Mary's Hospital Medical School. He now took up the study of the diseases of the nervous system as a whole, rather than the section of it met with in asylums. He was elected Assistant Physician to St. Mary's Hospital, and then shortly left it to accept the professorship of Pathological Anatomy and the position of Assistant Physician to the Hospital of University College. The same year he was also appointed Assistant Physician to the National Hospital for the Paralyzed and Epileptic. He has thus been in the midst of active and pressing professional studies, but Dr. Bastian has still found time for those laborious and purely scientific inquiries for which he is most extensively known. The following is a list of his chief memoirs and works, in the order of their publication:

"On the Structure and Nature of the Dracunculus or Guinea-Worm." "Trans. of Linn. Soc.," vol. xxiv.

"Monograph on the Anguillulidæ, or Free Nematoids, Marine, Land, and Freshwater; with Descriptions of 100 New Species." "Trans. of Linn. Soc.," vol. xxv.

"On the Anatomy and Physiology of the Nematoids, Parasitic and Free; with Observations on their Zoölogical Position and Affinities to the Echinoderms." "Philosophical Transactions," 1866.

"On the Mode of Origin of Secondary Cancerous Growths." *Medical Mirror*, vol. i., No. x.

"On the Specific Gravity of the Different Parts of the Human Brain." *Journal of Mental Science*, January, 1866.

"On the so-called Pacchionian Bodies." "Trans. of the Microsc. Soc.," July, 1866.

"On the Pathology of Tubercular Meningitis." *Edinburgh Journal of Medical Science*, April, 1867.

"On a Case of Concussion-Lesion of the Spinal Cord, with Extensive Ascending and Descending Secondary Degenerations." "Trans. of Medico-Chir. Soc.," 1867.

"On Cirrhosis of the Lungs." "Reynolds's System of Medicine," vol. iii.

Also the sections on "Pathology and Morbid Anatomy" of the following joint articles (by Dr. Reynolds and Dr. Bastian) appeared in "System of Medicine," vol. ii.: "Cerebritis;" "Non-Inflammatory Softening of the Brain;" "Congestion of the Brain;" "Hypertrophy of the Brain;" "Adventitious Products in the Brain."

"Modes of Origin of Lowest Organisms." *Macmillan*, May, 1871.

"The Beginnings of Life," 2 vols., Appletons, 1872.

"Evolution and the Origin of Life," Macmillan, 1874.

"On Paralysis from Brain-Disease in its Common Forms," Appletons, 1875.

CORRESPONDENCE.

A CORRECTION.

To the Editor of The Popular Science Monthly.

SIR: Please allow me to correct some errors in the notice (on page 760 of this journal for October) of the paper on "American Ganoids," read at the Detroit meeting of the American Association for the Advancement of Science.

The *very* young gar-pike (*Lepidosteus*), less than an inch long, has only *one* tail; a symmetrical organ like that of existing *Amphioxus* and *Polypterus*, and the fossil *Glyptolæmus*.

While from one to ten inches long, the growing gar manifests a *lower lobe of the caudal*. In this state it resembles the existing sturgeons and sharks, and many fossil Ganoids.

The filamentary original tail gradually decreases and finally disappears, while the lower lobe increases and becomes the functional tail of the adult *Lepidosteus* and *Amia*. In this respect, therefore, these forms are *modern* types of an ancient group.

In describing the peculiar vibratory movement of the caudal filament of the young gar, I compared it to the rapid vibration of the tail in many if not all serpents, and notably in the rattlesnake, and suggested that, in view of the ball-and-socket articulations of the vertebræ of *Lepidosteus* and some other reptilian features, the resemblance between the motions of *Lepidosteus* and *Crotalus* may have a deeper origin and significance than mere functional similarity; that they may have had a common ancestry not very remote. But I had no idea that "the ancestor of the gar was a reptile."

This correction seems to me the more desirable, since the other paper noticed by you (on the *Sirenia*) was chiefly to show that a retrograde metamorphosis had taken place with that group.

BURT G. WILDER.

ITHACA, N. Y., *September 27*, 1875.

FORESTS AND RAINFALL.

To the Editor of the Popular Science Monthly.

WHILE recently traveling among the mountains of this State, the threatening approach of a storm obliged me to find a shelter, whence my attention busied itself in watching the clouds gathering upon the slopes that reached at least two thousand feet above the valleys.

Some portions of them, I observed, became quickly covered; others more slowly. In due time the storm broke away, and, relieved partially of their watery burdens, the clouds commenced to lift and move off, but some more tardily than others. Moreover, I remarked that, where they had first collected, there they remained the longest, and that those parts of the acclivities concealed the last were the first to become visible.

Such a singular coincidence led me on further to the consideration of its cause. I think it may be extracted from the following facts: 1. The day had been very warm, as had also been the weather for a week before. 2. Of those portions of the slopes that had become hidden, the timbered lands were the first and, as mentioned above, the last to be seen again; the contrary happening to the rock-exposures. 3. The valley in which I was is formed by mountains over four thousand feet above sea-level, their opposing acclivities being very near to each other. It is therefore narrow, and it was shielded from the cooling influences of winds outside. 4. The radiation of heat from the bare sides and precipices.

Generalizing the conclusions that may be drawn from these, it may be said that sometimes clouds passing over barren surfaces, like some of those I had been viewing, will become lightened as the cohesion of their particles is weakened by the warmer ascending currents of air; they may be dispersed, and, even if they settle down, will be more likely to rise again before those covering forests.

With the latter it will be otherwise. Every leaf, like a miniature sun-shade, pro-

tects a part, small though it be, of the soil from the direct warmth of the sun. Forests thus are like great canopies sheltering from the sun's rays those sections upon which they grow. Lands so covered possess a capacity for holding much moisture. Contained in the leaves and trunks of trees, and more particularly in the spongy moss and numerous streams, it is saved from rapid evaporation, and consequently lowers the temperature of the atmosphere over it.

Vapors, then, attracted toward mountains by gravity, or carried thither by winds, will at times collect first over those sections which are wooded, and will have a tendency to remain there, be condensed, and deposit rain.

It may not be out of place to notice here another fact coming under my observation. Winds sweeping across a country, when they encounter mountains, are crowded against them, and, by the pressure from behind, are forced up along their sides and over their crests. Clouds that are in their paths, and which are borne onward to the slopes of such mountains, are sometimes carried up to and over their tops. Slopes which are destitute of timber present very few obstacles to such a result. Forests, on the other hand, break or lessen the mechanical strength of wind, and so increase the probability of their augmenting the volume of rainfall.

P. F. SCHOFIELD.

NEW YORK, *September*, 1875.

EDITOR'S TABLE.

WHICH UNIVERSE SHALL WE STUDY?

A CERTAIN class of astronomers have aimed to persuade us that there are "more worlds than one;" and those ingenious speculators Stewart and Tait have recently argued for two universes: the present universe, open to the sense, and an "unseen universe" beyond the range of direct scientific investigation but open to intrepid scientific faith. From another point of view this idea of two universes comes out in a much more definite and practical way; and that is when considered with reference to the two great orders of knowledge that are now making rival claims on the attention of mankind as means of education. This conception of two universes as objects of thought was very instructively set forth by the able author of the articles we have published under the title of "The Deeper Harmonies of Science and Religion," in his third paper, and the passage defining the distinction is so well drawn that it will bear repetition. The writer says:

"There is something which sets itself up as a just reflection of the universe, and which it is possible to study as if it were the universe itself; that is, the multitude of traditional unscientific opinions about the universe. These opinions are, in one sense, part of the universe; to study them from the historic point of view is to study the universe; but when they are assumed as an accurate reflection of it so as to divert attention from the original, as they are by all the votaries of authority or tradition, then they may be regarded as a spurious universe outside and apart from the real one, and such students of opinion may be said to study, and yet not to study the universe.

"This spurious universe is almost as great as the genuine one. There are many profoundly learned men whose whole learning relates to it and has no concern whatever with reality. The simplest peasant, who, from living much in the open air, has found for himself, unconsciously, some rules to guide him in divining the weather, knows something about the real universe; but an indefatigable student, who has stored a prodigious memory with what the schoolmen have thought, what the philosophers have thought, what the fathers have thought, may yet have no

real knowledge; he may have been busy only with the reflected universe. Not that the thoughts of dead thinkers stored up in books are not part of the universe as well as wind and rain; not that they may not repay study quite as well; they are deposits of the human mind, and by studying them much may be discovered about the human mind, the ways of its operation, the stages of its development. Nor yet that the thoughts of the dead may not be of the greatest help to one who is studying the universe: he may get from them suggestions, theories, which he may put to the test, and thus convert, in some cases, into real knowledge. But there is a third way in which he may treat them which makes books the very antithesis to reality, and the knowledge of books the knowledge of a spurious universe. This is when he contents himself with storing their contents in his mind, and does not attempt to put them to any test, whether from superstitious reverence or from an excessive pleasure in mere language. He may show wonderful ability in thus assimilating books, wonderful retentiveness, wonderful accuracy, wonderful acuteness; nay, if he clearly understands that he is only dealing with opinions, he may do good service in that department, for opinions need collecting and classifying as much as botanical specimens. But one often sees such collectors mistaking opinions for truths, and depending for their views of the universe entirely upon these opinions, which they accept implicitly without testing them. Such men may be said to study, but not to study the universe."

This discrimination is both true and highly significant. Old opinions, old languages, and antiquated learning, are fit subjects of study as a part of archæology, like old buildings, old costumes, old coins, ear-rings, pictures, etc., which are not without a certain historic interest. But from this point of view they are parts of the universe to be explored and explained, like all the rest of it, by scientific methods. This, however, is a widely different thing from setting up old knowledges and thoughts of the dead as systematic and exclusive objects of study, and the sufficient means of mental cultivation. Yet the advocates of education by traditional, unscientific studies habitually slur over this distinction, and, declaring that old languages and old traditional ideas are as much parts of the universe as the rocks and stars, proceed to install them into a separate world in which the great multitude of students are made to pass their whole intellectual lives. It is no exaggeration or mere figure of speech to characterize this realm of antiquated thought and dead language as a spurious universe. No one will deny that the broad and distinctive object of scientific study is the real and present universe of phenomena, fact, and law, which is open to the direct, immediate action of the human mind. The study of it in all its phases, by observation, experiment, analysis, synthesis, and classification, has given rise to a vast body of truths and principles known as scientific knowledge, or modern scientific thought, and by which and through which the actual living universe is to be interpreted and known. Obviously the keys to the knowledge of the real universe are held by science, and it is inevitable that, if scientific knowledge be left out of any educational scheme, the genuine universe is omitted from that scheme. And when this subtraction has been accomplished what remains? An unreal sham, an illusive, discordant representation of things which may now be justly termed a "spurious universe." We say it may *now* be justly so termed, although, before the true universe was discovered, there could have been no knowledge of its counterfeit. The mass of pre-scientific opinion concerning the world and its contents, the course of Nature, man, life, and society, when taken in relation to what is now

known of these subjects, and when regarded as a body of thought to be employed for purposes of culture, must be held as representing not the universe of reality, but only a distorted and spurious semblance of it.

The question of scientific education, then, undoubtedly the greatest question of our time, is simply this: "Shall we study the genuine or the spurious universe? Shall the minds of students be developed and moulded by direct exercise upon the phenomena and problems of Nature and present human experience, or shall they be cut off from the living world and trained in the acquisition of old knowledges, just as if science had never arisen?" This question may seem to many a futile one, as they will say that in this age the influence of science cannot be escaped. Nevertheless it is an urgent and a practical question. For, although the influence of science cannot be escaped by society, it can be and it is extensively evaded and escaped in education. In this our schools and colleges do not represent the age; they are out of harmony with it; they are far behind it. The genuine universe is not the supreme object of study; it is only partially recognized or not recognized at all. The spurious universe is still in the saddle. It has not been displaced; it has hardly been disturbed. Science is still begging of our colleges for a few crumbs; and, when snubbed, is trying here and there to organize schools of its own, which are generally looked upon as mere technological shops where needy youths are apprenticed to bread-and-butter occupations a grade or two above the workshops of artisans and mechanics. The dignity of being liberally educated, the honors of scholarship, and the prestige of culture, are reserved for those who, passing by all the grand results of modern science, give themselves to the study of the spurious universe.

The latest illustration that comes to us of the extent to which this statement is true, is furnished by the condition of the great public or preparatory schools of England. An official report has been made upon this subject, which represents the state of things after a quarter of a century of vehement agitation for some reformatory change that shall bring the popular culture of that country into greater harmony with the present state of knowledge. The case is thus forcibly presented by the London *Spectator*, a journal that will not be suspected of extreme views upon the subject:

"During the past three hundred years, the spread of scientific knowledge has revolutionized European modes of thought, has fundamentally altered the European idea of the universe, of the earth's place in the grand whole, and of man's place on the earth, and has profoundly modified European social life and political institutions; but, to our great schools, science has been as if it had made no progress. To those who have regulated the studies of those places of learning, it has not appeared at all important that English gentlemen should be able to follow with intelligence the fruitful researches to which the pioneers of modern thought were devoting themselves, should be capable of appreciating the discoveries which were abridging space, approximating classes, and calling into existence industries, activities, and relations, that are gradually transforming the ancient order of things—in a word, that they should be in sympathy with the modern spirit. . . . Of course, such a state of things has not been allowed to continue without protest and controversy, and some little has been done to make room for science-teaching in our schools. It has, however, been very little. The sixth report of the Royal Commission on scientific instruction now lies before us. It is confined exclusively to an examination into the provision made in the various secondary schools throughout the country for the teaching of science, and this is what appears: Returns, more or less complete, were re-

ceived from one hundred and twenty-eight endowed schools in all, and, out of this total, 'science is taught in only sixty-three, and of these only thirteen have a laboratory, and only eighteen apparatus, often very scanty.' Even these figures, however, give but a very imperfect notion of the neglect with which science is treated. It will hardly be believed that there are no more than eighteen of these schools which devote as much as four hours in the week to scientific instruction, that sixteen actually afford no longer time than two hours a week, and seven think an hour sufficient. These, however, are the good examples. There are thirty schools in which no definite time whatever is allotted to scientific study. Again, out of the one hundred and twenty-eight schools, only thirteen give any place at all to science in their examinations, and 'only two attach a weight to science in the examinations equal to that of classics or mathematics.'

"If, now, we attempt to account for this extraordinary neglect of science, in a country whose greatness, if not its very independence, depends upon the skill of its population in using the forces of Nature as their servants, we find the blame to rest in a very great measure on the universities. The older universities were founded and attained celebrity at a time when natural science did not exist, and they have never admitted science to an equality with classics and mathematics. The feeling of Oxford and Cambridge has naturally guided the public schools. The masters are, almost without exception, even to-day, Oxford and Cambridge men, and are penetrated with the Oxford and Cambridge spirit. Moreover, the parents of the boys, and the boys themselves, necessarily attach importance to the studies which will win honors and distinction at the universities, while they disregard studies that will in no way help them in their careers. Lastly, the neglect of science at the universities causes the schools to suffer from a want of competent teachers. Most of the head-masters in their evidence refer to this difficulty, but, at the same time, they are unwilling to look elsewhere for the kind of men they want. Thus the head-master of Rugby says: 'I would here observe that a mere chemist, geologist, or naturalist, however eminent in his own special department, would hardly be able to take his place in a body of masters composed of university men, without some injurious effect upon the position which science ought to occupy in the school. . . . In preferring the two older universities, I do so only by reason of their stronger general sympathies with public-school teaching. I am aware that if I merely wanted a highly-scientific man in any branch, I might find him equally in Dublin, London, or at a Scotch university.' In plain language, trades-unionism forbids an ugly competition."

It thus appears that the policy of one hundred and twenty-eight of the leading schools of England, in regard to the admission of scientific studies, is powerfully influenced, if not controlled, by the universities, so that, in the foremost nation in the world, there is a vast, compactly-organized educational system which ignores the universe, as disclosed by modern science, and employs as its means of mental cultivation a spurious universe of dead traditions, languages, methods, and opinions.

LITERARY NOTICES.

FIRST BOOK OF ZOÖLOGY. By EDWARD S. MORSE, Ph. D., late Professor of Comparative Anatomy and Zoölogy in Bowdoin College. New York: D. Appleton & Co. Pp. 188. Price, $1.25.

THE genius for good school-book making is incontestably American. Our best school-books exemplify art in two directions: in that which goes to the getting up of the

book, materially, and that which concerns its intellectual self; that is, its way of putting things—such a handling of teaching processes as recognizes that good teaching is an art, and the true teacher an artist. As good tools for teacher and learner, American school geographies, arithmetics, readers, and lately grammars, are not excelled abroad. It is noteworthy, however, that hitherto so much could not be said of American efforts in the matter of elementary school-books on science. Herein has England set us an example. The "Science Primers," reprinted by the Appletons, are very remarkable books as showing how a high knowledge in these departments may be set before a little child. However, in this matter of American science-teaching of the little ones, the tide is setting in. It must be admitted that in every thing pertaining to books, and elementary teaching of animated Nature, we are far behind England. Dr. Hooker's "Child's Book of Nature" is the best of its class, though sadly needing rewriting. But when we come to zoölogy proper, a history of our efforts at elementary book-making is more interesting than creditable. The earliest serious effort is that of Daniel Haskel—"The Juvenile Class-Book of Natural History," 1841. It is for children, and the author boasts in the following style over its systematic arrangement: "The classification, which forms an important feature of the work, is founded on external resemblance and visible habits. . . . This classification is much more simple, and better adapted to the young mind, than that of Linnæus, which is founded on occult resemblances, and ranks the cow and the whale, animals which inhabit different elements, and are otherwise very unlike, in the same general class, *Mammalia*." As to man, he says, "Buffon divides mankind into six classes," and he does likewise. But the word "class," though often used, has no certain sense in this little book. Leaving man, the work is divided into Quadrupeds, Birds, Fishes, Reptiles, and Insects. The quadrupeds are divided into thirteen classes, as first class, second class, etc. Then come the "Unclassed Animals," viz., "the elephant, rhinoceros, hippopotamus, tapir, camel, Arabian camel, llama, camelopard, bear, badger, raccoon, kangaroo, opossum, ant-eater, sloth, jerboa." He says these "are animals which cannot be classed, but each of which by itself forms a distinct species." The birds are given in like manner in six classes, with "unclassed birds, the ostrich, cassowary, dodo." The fishes are in four classes. The first class embraces the cachelot, grampus, porpoise, dolphin, whale." As for the sword-fish, he is left out in the cold. The "fourth class" of fishes embraces the lobster, crab, tortoise, oysters, snails, and such.

The next attempt at a natural history for schools was (we speak from memory) by Abram Ackerman. It was a mere compilation, with not a particle of science behind it or in it. It had the credit, however, of not being the injurious book that Haskel's was. In 1849 appeared "Class-Book of Zoölogy: designed to afford to Pupils in Common Schools and Academies a Knowledge of the Animal Kingdom. By Prof. B. Jaeger." The educational plane was not then up to this little book, which, as a classification, or systematic exhibit of the animal kingdom, had not its equal; and, besides this, much of it was really American, but zoölogy proper it utterly failed to teach. Prof. Worthington Hooker's "Natural History, for the Use of Schools and Families," appeared in 1860. It is a good book, and holds its own in the market because of its pleasant and readable style. As a classification it is too meagre, and of zoölogy it contains but little. We must not pass unmentioned the Ruschenberger series of "First Books in Natural History," begun in 1842. These were little else than translations from the text of Milne Edwards and Achille Comte. Very excellent little manuals they were, but extending, as they did, to eight volumes, they lost all claim to be called a "Primer of Natural History." "Principles of Zoölogy, by Agassiz and Gould," 1848, is a high text-book; and of a like nature must be regarded "A Manual of Zoölogy," by Sanborn Tenney, 1865, with its smaller companion by the same author; both good books so far as systematizing goes.

It is evident, then, that a good, true American book, worthy of being called a "Primer of Zoölogy," had not appeared. In the fullness of belief, we avow our con-

viction that it has come at last. We do not allude to Mrs. Stevenson's "Biology for Boys and Girls;" it occupies a widely-different field. "First Book of Zoölogy," by Prof. Morse, is the little work which we wish to consider. It has some points on which we would for a moment dwell. First, it really teaches zoölogy. It deals with the morphology and actual structure of familiar things. It advises you to get snails or insects, and shows how to get them. Now, every one should know that this is just what a child wants to do. Every child is naturally a collector. Then comes the study of form. Here are simple outline drawings. The external parts are laid out, and each part is shown to the pupil, and its name as a part is given. Now the child must draw these parts on his slate, and then name them for himself; and every child with a little patient help can do all this. But, when this is done, the morphology of a shell, or whatever else, is well learned, albeit the little pupil has never heard the big word used above. And what an eye-opener, and mind-expander, and tongue-loosener, half an hour of such work with a child is! The little child becomes at once a naturalist, intent upon his snail, he sees things, and thinks things, and asks things, that are all new to him. This little book utterly eschews technicalities, and even classification. An intelligent boy will make a collection, and then will attempt to sort it into groups or sets of real or fancied similitudes. This is instinctive classification. But it is plain that the collection must come first; that is, that intelligent classification must stand related to things more than words. A blind man could not classify the stars. Here, then, is the blunder which our author shuns: of beginning to teach systematic classification with no knowledge or sight of the objects. The author's method is that of Nature. It is the word-method in reading instead of the old A B C plan. Get your object, then learn its parts, and, thus trained, classification will be sought for, and can then be entered upon; and even its systematic names will be learned with delight, because they have a real significance; that, of course, will be the work of a "Second Book." The first is just such as any teacher can handle, and that too with pleasure, for it unfolds the objects of Nature precisely in Nature's own way. A real excellence in a primer is, that it is small. This little book reminds us of the pinhole in the card to which the eye is applied; it takes in a very little bit of Nature, but that bit is wonderfully amplified with good, clear, achromatic light. In this wise it is that one who has done a long service in teaching natural history to children hails Dr. Morse's little book. S. L.

MONEY, AND THE MECHANISM OF EXCHANGE. By W. STANLEY JEVONS, F. R. S., Professor of Logic and Political Economy in the Owens College, Manchester. No. XVII. "International Scientific Series." New York: D. Appleton & Co. 350 pages. Price, $1.50.

THERE is, beyond question, a most important scientific side to the complex subject of money. It has its observable phenomena, its analyzable relations, and its deducible laws; and, as it pertains to the operations of human society, it is a legitimate branch of social science. For this reason it was entirely proper that the subject should be treated in an independent monograph in the "International Scientific Series." One of the ablest and clearest logical heads in Europe, author of a masterly treatise on the philosophy of science, and a special and thorough student of political economy, was chosen to execute the work. Again there were permanent, general, and what we may term cosmopolitan reasons for taking up the subject with a view simply to the exposition, improvement, and extension of valuable knowledge.

But for us the subject has also quite another aspect. There were urgent American reasons why it should be treated. We believe in the glorious leadership of our country; we are in advance, and bound to be in advance, of civilization, and in this case the American people furnish ample evidence that they are quite ahead of the world in their ignorance of every thing like principles or laws relating to money. The American voter, with his hands full of greenbacks, has about as much understanding of the science which treats of them as the Indian of the science of wampum. That they can buy things with them, and that

they are therefore desirable to be got, exhaust the knowledge of both. With all our vaunted enlightenment, we have a currency bedeviled by politicians in the interest of selfish greed and rampant speculation, and maintained by a demagoguism as unscrupulous and vicious as the world has ever seen. With so much gross ignorance and stupid superstition among the people in regard to the nature of money, and the laws of its use and influence, that the present state of things is openly defended and its continuance demanded, it becomes in the highest degree desirable that sounder views should be disseminated as rapidly and as widely as possible. We want a knowledge of money as a branch of natural history. We want to know how its use has grown up; what wants it answers to in human societies; what laws it is subject to that spring from the very nature of things; what are its imperfections, and how they may be supplemented; what are its dangers, and what the delusions and impostures of which it is made the means by calculating men and unprincipled governments. Prof. Jevons's work deals with the subject very much from this point of view. He offers us what a clear-sighted, cool-headed, scientific student has to say on the nature, properties, and natural laws of money, without regard to local interests or national bias. His work is popularly written, and every page is replete with solid instruction of a kind that is just now lamentably needed by multitudes of our people who are victimized by the grossest fallacies.

RELIGION AND SCIENCE IN THEIR RELATION TO PHILOSOPHY. By CHARLES W. SHIELDS, D. D. New York: Scribner, Armstrong & Co. Pp. 69. Price, $1.00.

THIS essay consists of two parts, in the first of which are stated the scientific hypotheses and the religious dogmas that have been offered for the solution of such problems as the origin of the universe, the formation of geological strata, the origin of man, the nature of mind and of matter. The case for both sides is stated fairly enough. In the second part the author endeavors to show that these problems are neither exclusively scientific nor exclusively religious, but philosophical. "It is not too much to say that they can never be decided by any merely scientific process. . . . And it is safe to say that by no purely religious method can they ever be settled." The author regards these problems as "partly scientific and partly religious," but "strictly philosophical." Hence philosophy is the umpire when religion and science are in conflict. "Paramount as religion must be in her own sphere with her inspired Bible and her illumined Church," she cannot judge the theories of science; but no more will religious men accept from mere scientists a judgment upon their doctrines. The author thinks that in the "broad plain of philosophy" the religionist should accept scientific truth resting upon "foundations of proof that cannot be shaken;" and that the scientist should no longer ignore "that vast body of truths, doctrines, dogmas, backed by evidences which have been accumulating for eighteen centuries under the most searching criticism." There appears to be no reason why men of science should reject the arbitration of philosophy.

PROCEEDINGS OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES; from May, 1874, to May, 1875. Selected from the Records. Boston: John Wilson & Son, 1875.

THIS is the second octavo volume of "Proceedings" of the "New Series," and the tenth of the "Whole Series" published by the American Academy; Volume I. having been published in 1848. Besides the octavo *Proceedings*, the Academy has long published quarto volumes of *Memoirs* which are of the highest value. This volume contains 535 pages, of which 462 are devoted to scientific papers, 13 to brief notes of the several stated meetings, 41 to the Report of the Council (into which are incorporated the obituaries of deceased members or associates), six pages to the list of the members, etc., and the rest of the volume to a very copious index.

We learn that the Academy contains 195 Fellows, 91 Associate Fellows, and 70 Foreign Honorary Members. The losses by death during 1874 have been painfully large, and many of them will not be felt by Massachusetts alone, but by the world at large. Short biographical notices are given of the following deceased members: B. R. Curtis, ex-Judge Supreme Court; George Derby, M. D., Professor, Harvard College; F. C. Lowell;

Charles G. Putnam, M. D.; Nathaniel B. Shurtleff; James Walker, ex-President Harvard College; Jeffries Wyman, Professor, Harvard College; F. W. A. Argelander, Professor, University of Bonn; Elie de Beaumont, Secretary Paris Academy of Sciences; Sir William Fairbairn, F. R. S., etc.; F. P. G. Guizot; Sir Charles Lyell.

Of the scientific papers given, ten are devoted to Chemistry and Physics, four to Botany, four to Astronomy and Astronomical Physics, two to pure Mathematics, etc. But such an enumeration does not convey any adequate idea of the amount of original research represented by this volume, which is in every way creditable to American science, and fully equal to similar publications in Europe. It is not possible within the limits of our space to attempt any analysis of individual papers, for a knowledge of which reference must be made to the volume itself; but it is impossible to avoid a renewed notice of the remarkable freshness of the volume as a whole. It bears the evidence of being the systematized results of faithful work in the laboratory, the field, and the study, and it has in this and in other respects an advantage not common to all American publications of the same kind.

AMERICAN STATE UNIVERSITIES. With a Particular Account of the Rise and Development of the University of Michigan. By ANDREW TEN BROOK. 418 pages. Price, $3.50. Cincinnati: R. Clarke & Co.

THE author of this work, in his first chapter, presents a sketch of the early progress of academic education in the Atlantic States. Next he describes the state of culture in the West at the beginning of the congressional land-grant policy and subsequently. The history of congressional land-grants for universities is given in the third chapter. The remainder of the book is more specially devoted to the subject of education in Michigan, and the matters treated in the successive chapters are: Michigan's early condition as to culture and education; early organization for higher education in that Territory; grant of the present university fund, and its administration by the board of trustees; organization of the school system and administration of the endowment fund; rise of union schools; opening of the Ann Arbor University; review of the period from 1844 to 1852; the administration of President Tappan; administration of President Haven and his successors. Finally, the author essays to forecast the future of American universities. He is in favor of retaining the study of ancient languages as the dominant feature, the very backbone of the university system. "The long-agitated question," he says, "of the place which the Latin and Greek languages should hold in education, the University of Michigan settled originally by giving them the same prominence which they had in the old colleges of this country, and the State universities generally have inclined to this course. This action needs no comment or defense beyond a statement of the reasons which have been supposed to justify it. The relation of the study of these languages to that of other subjects has been greatly changed by the introduction of new branches of study, but not by any special change of views in regard to the value of languages themselves." Science, according to Mr. Ten Brook, is of little or no importance except for specialists. "Language is of all studies the most practical. The useful and sublime sciences, such as chemistry, botany, geology, and astronomy, *are of little immediate use even to the learned.* Their main facts and generalizations are indeed well employed in literature, in philosophy, and in social life; *but beyond these they are only to be pursued by the special student.*" Again, he says: "It was the ancient classics, and the Hebrew and Greek Scriptures in their originals, which awakened Europe from the sleep of the middle ages. They are adapted to just that kind of work, and they will probably hold their place for ages to come, as for centuries past, in the course of higher education." Our own views on this question are fully stated in the leading editorial of the present number.

ANNUAL REPORT OF THE DIRECTORS OF THE ST. LOUIS PUBLIC SCHOOLS. Pp. 398.

BESIDES the usual statistics, the various annual reports contained in this volume convey a large amount of valuable information on school management in general. The idea of having attached to the Normal School

a "School for Observation" appears to be original to the St. Louis system. This school for observation differs from the "Model School" in that the Normal scholars here simply observe the process of managing a school as conducted by highly-competent teachers, while in the Model School they make experiments in teaching. The school selected for observation is one of the district schools of the city. The members of the senior and middle classes of the Normal School are sent regularly to the "School for Observation" in order to acquire a more thorough knowledge of their future profession.

The experiment begun two years ago, of establishing a Kindergarten in connection with one of the public schools, has, according to the Report, proved a decided success. Like every effort toward new and improved methods in education, the project, at the outset, met with strong opposition. It was urged that children enough would not attend to justify the expense. The younger children of three and four could not be sufficiently interested; small children would not attend regularly; the training would unfit for ordinary primary work; the physical exercises would be injurious to health; and so on, to the end of the string of imaginary difficulties that objectors are forever ready to throw in the way. The result was that, when the school opened, the room was quickly filled. At the beginning of the second year nearly all the children of the previous year reëntered, and a second room of equal capacity was found necessary, and this also was filled. The average attendance was ninety-five per cent., exceeding that in the primary rooms. The children advanced to the primary department made rapid progress in its studies, excelling rather than falling behind their fellows. The physical exercise produced a marked improvement in the health and general appearance of the pupils; and, finally, it has been determined to establish Kindergartens in two more of the public schools.

This and other parts of the Report show what preceding reports from the same source had previously shown, that the authorities in St. Louis are alive to the necessity for improvement in our methods of primary instruction, and it would be well if school-officers in Eastern towns could be charged with a similar spirit. The streets of New York, for example, are swarming with children from three to six years old, receiving at the most impressible period of their lives the lessons that only the streets can teach. If, in place of these abominable associations, they were gathered into Kindergartens, the formation of habits that later become actual obstacles in education would be in great part prevented, while a positive advantage would be gained in the training which such schools afford.

PUBLICATIONS RECEIVED.

Reference and Dose Book. By C. Henri Leonard. 16mo, 80 pages. Price, 75 cents; and Vest Pocket Anatomist. By same. 16mo. Price, 50 cents. Detroit, 1875. Pp. 56.

The Origin of the Sun's Heat and the Chemical Constitution of the Matter of his System. By William Coutie. Troy, 1875. Pp. 23.

Tinnitus Aurium. A Consideration of the Causes upon which it depends, and an Attempt to explain its Production in Accordance with Physical Principles. By Samuel Theobald, M. D. Baltimore: Innes & Co., Printers. 1875. Pp. 13.

Circulars of Information of the Bureau of Education. No. 6. Washington: Government Printing-Office, 1875. Pp. 208.

On the Flexure of Continuous Girders. By Mansfield Merriman, C. E. 1875. Pp. 12.

Printing for the Blind. Reply to the Report of a Committee of the American Social Science Association. By the Trustees of the American Printing-House for the Blind. Louisville, Ky., 1875. Pp. 16.

Have we Two Brains? Soul and Instinct, Spirit and Intellect. Address by Rector of St. Mary's Church, Station O, N. Y. 1875. Pp. 12. Price, 10 cents.

Alimentation of Infants and Young Children. By B. F. Dawson, M. D. New York: William Wood & Co. 1875. Pp. 22.

Catalogue of the Iowa State University for 1874–'75.

A Graphic Method for solving certain Algebraic Problems. By George L. Vose. New York: D. Van Nostrand. 1875. Pp. 62. Price, 50 cents.

Manual for the Use of the Globes. By Joseph Schedler. New York: E. Steiger. 1875. Pp. 34. Price, 25 cents.

Consciousness in Evolution. A Lecture delivered before the Franklin Institute, Philadelphia. By E. D. Cope, 1875. Pp. 16.

Our Teeth and their Preservation. By L. P. Meredith. Cincinnati, 1875. Pp. 43.

History of the Philadelphia School of Anatomy. By William W. Keen, M. D. Philadelphia: Lippincott & Co., 1875. Pp. 32.

Anatomical, Pathological, and Surgical Uses of Chloral. By same. 1875. Pp. 11.

Experiments on the Laryngeal Nerves and Muscles of Respiration in a Criminal executed by Hanging. By W. W. Keen, M. D. 1875. Pp. 8.

Matter and the Laws of Matter; and The Self-Existence of Matter inconsistent with the Existence of God. By William H. Williams. Each ten pages.

Iowa Weather Review, September, 1875. Edited and published by Dr. Gustavus Hinrichs, Iowa City, Iowa.

A Study of the Normal Movements of the Unimpregnated Uterus. By Ely Van De Warker, M. D. New York: D. Appleton & Co., 1875. Pp. 26.

On the Transcendental Curves whose Equation is, $\sin y \sin my = a \sin x \sin nx + b$. By H. A. Newton and A. W. Phillips. Reprinted from Transactions of Connecticut Academy.

A New Basis for Uterine Pathology. By A. F. A. King, M. D. New York: William Wood & Co., 1875. Pp. 20.

The Uranian and Neptunian Systems investigated with the 26-Inch Equatorial of the United States Naval Observatory. By Simon Newcomb. Washington, 1875. Pp. 74.

The Relation of the Patent Laws to American Agriculture, Arts, and Industries. Address by James A. Whitney before the New York Society of Practical Engineering. New York, 1875. Pp. 37.

Annual Report of the Superintendent of Public Instruction, on the Public Schools of New Hampshire. Concord, 1875.

Nature and Culture. By Harvey Rice. Boston: Lee & Shepard, 1875. Pp. 202. Price, $1.50.

A Manual of Metallurgy. By William H. Greenwood, F. C. S. New York: G. P. Putnam's Sons. Pp. 370. Price, $1.50.

Cholera Epidemic of 1873 in the United States. Pub. Doc. Washington, 1875. 1025 pages.

Vision: Its Optical Defects and the Adaptation of Spectacles. By C. S. Fenner, M. D. Philadelphia: Lindsay & Blakiston, 1875. Pp. 300. Price, $3.50.

Scripture Speculations. By H. R. Stevens. Newburg, N. Y., 1875. Pp. 415. Price, $2.00.

MISCELLANY.

We present below brief abstracts of some of the more interesting papers read at the last meeting of the British Association for the Advancement of Science. Others will follow in succeeding numbers.

Ice-Action.—The subject of ice-action was considered in a paper read by D. Mackintosh, F. G. S. He first discussed the question whether the so-called continental ice of Greenland was a true ice-sheet formed independently of mountains, or merely the result of a confluent system of glaciers. He then considered the state of the surface of the Greenland ice-sheet, and believed that the amount of moraine matter was locally limited and of small extent. He defended the idea of the internal purity of existing ice-sheets, and gave reasons for doubting whether glaciers are capable of persistently pushing forward the large stones they may find in their beds, though he admitted that the base of glaciers is charged with finer *débris*, by means of which they grind and striate rock-surfaces. He mentioned that in the lake district of England he had never seen a sharply-bordered groove on a glaciated rock-surface which might not have been produced by a stone smaller than a walnut.

He saw no reason for doubting that re-

volving icebergs were capable of scooping out hollows in the rocky bottom of the sea, and thought that lake-basins on the rocky summits of hills or on water-sheds might have been produced in this way. He then gave reasons for supposing that the drift-knolls called *eskers*, where their forms were very abrupt, might have been partly formed by eddying currents with waves generated or intensified by ice-movements, which sometimes would set the sea in motion as much as sixteen miles off.

According to Mr. Mackintosh, floating coast-ice is the principal transporter and glaciator of stones, and the uniformly striated stones found in the bowlder-clay were both glaciated and transported by coast-ice. He entered minutely into a consideration of how stones, previously more or less rounded, became flattened and uniformly grooved on one, two, or more sides, the grooves on the various sides differing in their directions. He believed that many of the stones found in the bowlder-clay of Cheshire must have been frequently dropped and again picked up by coast-ice during the passage from their original positions.

Ancestors of the British.—Another paper by the same author was devoted to the discussion of certain ethnological questions connected with the history of the people of Britain. He believed that the inhabitants of different parts of England and Wales differed so much in their physical and mental characteristics that many tribes must have retained their peculiarities since their colonization of the country, by remaining in certain localities with little mutual interblending, or through the process of amalgamation failing to obliterate the more hardened characteristics. The first type noticed was the Gaelic. In Cæsar's time, probably the great mass of the people of Gaul were comparatively dark in complexion and small in stature; and the race characterized by Cæsar as of tall stature, reddish hair, and blue eyes, were most likely German colonists of Gaul. There still exists in England, Wales, and Ireland, a distinct race, possessed of some of the mental characteristics anciently attributed to the Gaels. In mental character the Gaels are excitable, and alternately lively and melancholy. The Gael is also by temperament an excellent soldier, but he needs to be commanded by a race possessed of moral determination, tempered by judgment and foresight. Another characteristic of the Gaelic race is sociability.

In North Wales there are several distinct ethnological types, but by far the most prevalent is the type to which the term Cymrian may be applied. The Cymri appear to have entered Wales from the north. They are an industrious race, living on scanty fare without murmuring. Mr. Mackintosh gave a minute description of the physical and mental peculiarities of Saxons, and showed the difference between Saxons and Danes. With Worsaae, he believes that the Danes have impressed their character on the inhabitants of the northeastern half of England. He endeavored to show that between the northeast and southwest the difference in the character of the people is so great as to give a semi-nationality to each division. Restless activity, ambition, and commercial speculation, predominate in the northeast; contentment and leisure of reflection in the southwest. He concluded by a reference to the derivation of the settlers of New England from the southwest, mentioning the fact that, while a large proportion of New England surnames are still found in Devon and Dorset, there is a small village, called Boston, near Totnes, and in its immediate neighborhood a place called Bunker Hill.

Changes in the Courses of Rivers.—Major Herbert Wood spoke on the cause of the change of direction in the lower course of the river Oxus, by which its mouth had been diverted from the Caspian to the Aral. In the opinion of Major Wood this change is to be attributed to the abstraction of the water of the river for the purposes of irrigation, which has been practised from time immemorial. The quantity of water thus diverted has never been calculated, but, from data obtained by Major Wood during the Russian Expedition, he concludes that, between June 23 and September 10, 1874, an average of 62,350 cubic feet per second was absorbed by the irrigation canals of Khiva, an amount equal to nearly one-half the total volume of the

Oxus. At the time when the river emptied itself into the Caspian the conditions of its *régime* were such that the volume and velocity of its summer or flood water were sufficient to clear away annually from its bed the deposits of mud resulting from the smaller volume of its winter course. From certain data it is concluded that the difference of the delivery of water between winter and summer is as one to three: thus the bed would not undergo any deterioration, its course would remain unchanged, and the river would continue to discharge itself into the Caspian. But, as soon as the volume and velocity of its summer waters were diminished by the action of irrigation canals, those compensatory arrangements of Nature would be upset, and a proportion of the muddy deposits of winter would escape the annual scouring. In course of time bars would form in the bed of the river, and in the end prevent it extending its course to the Caspian. That the Oxus has changed its lower course is proved by numerous historical documents.

Antiquity of the Divining-Rod.—A paper on "Rabdomancy" (or the use of the "divining-rod") and "Belomancy" (or divination by means of arrows) was read by Miss A. W. Buckland. According to the author, the staff as a sceptre was probably a later form of the horn which was thus used in prehistoric times, and in that character adorned the heads of gods. From this use of rods or horns arose a veneration for them as possessing the power of healing. Hence their use by magicians, whose chief instruments have always been a ring and a staff. These symbols conjoined are found in Egyptian, Assyrian, and Peruvian sculptures, and may be traced in some of the stone circles of Britain and in the shape of ancient Irish brooches. Belomancy, or divination by marked arrows, said to be of Scythian origin, was practised in Babylon, Judea, and Arabia, and traces of it may still be found in the popular tales of Russia and Siberia. "That the arts of magic and divination are a remnant of pre-Aryan religion is proved," said the author, "by their present existence among aboriginal non-Aryan races; and they might even be used as a test of race, so that those who in the counties of Somerset and Cornwall claim the power of divination by the rod might possibly have some remote affinity with the aboriginal inhabitants of Britain."

The Clinical Thermoscope.—Dr. Seguin, of this city, has devised an ingenious little instrument, called the clinical thermoscope, to be used as an aid in diagnosis. It is employed for detecting the variations of temperature on the surface of the body, and estimating the rate of radiation going on therefrom. In the words of the inventor, it is "intended as a quicker and more delicate test of differential temperatures than the thermometer; and less to give the degree of heat than the velocity of its radiation." We present a cut of the instrument half the actual size. It consists of a glass tube seven inches long, with a minute bore open at one end, and terminating at the other in a bulb. An adjustable scale is attached to the outside of the tube. To prepare it for use, immerse the bulb in hot water, which rarefies the air inside. The open end is then plunged into cold water and quickly withdrawn, when a drop or two will be found to have entered the tube. This forms a "water-index," which should become stationary within an inch or two of the bulb. If it falls into the bulb, or does not approach it sufficiently, too much or too little heat was applied in the first instance, and it will be necessary to jar the water from the tube and try again. When the index is provided, adjust the scale, bringing its lowest figure on a level with the top of the column of water in the tube, and it is then ready for use. It may be applied to any part of the surface, where disturbance of temperature is suspected, but its habitual place in the hands of Dr. Seguin is, not the axilla, but the shut hand. The claims

for it are, that it gives by contact indications of the volume of heat escaping by radiation, and the velocity of loss; also, that by blowing on the bulb the degree of combustion that takes place in the lungs is shown. It is likewise serviceable as a means of detecting the exact position of deep-seated local trouble, giving valuable indications where the thermometer fails.

A New Fossil Crustacean.—A new crustacean species, allied to *Eurypterus* and *Pterogotus*, has been described by A. R. Grote and W. H. Pitt, under the name of *Eusarcus scorpionis*. The specimen was found in the water-lime group at Buffalo, N. Y. Its length is 250 millimetres, and its greatest width 110 millimetres. The cephalo-thoracic portion appears to be separate from the body; the legs are in the same number as in *Eurypterus*; the swimming-feet appear to differ by the straighter, less rounded outer margins; the spines of the anterior feet appear to be long, curved, and to have an anterior direction. The absence of chelate appendages to the posterior margin of the feet is particularly noticeable. The first seven broad segments of the abdomen form a large ellipse. There is an evident and remarkable narrowing of the succeeding caudal segments. The interest which attaches to this remarkable crustacean arises from the discovery of a form which may be allowed to be higher than *Eurypterus* and *Pterogotus*.

Reptilian Affinities of Birds.—Prof. E. S. Morse has for a long time made a study of the bones of embryo birds. At this year's meeting of the American Association he recalled briefly the evidence he had shown last year regarding the existence of the intermedium in birds, by citing the embryo tern, in which he had distinctly found it. This year he had made a visit to Grand Menan, expressly to study the embryology of the lower birds, and was fortunate in finding the occurrence of this bone in the petrel, sea-pigeon, and eider-duck. This additional evidence showed beyond question the existence of four tarsal bones in birds as well as four carpal ones. In these investigations he had also discovered embryo claws on two of the fingers of the wing—the index and middle finger. Heretofore in the adult bird a single claw only had occurred in a few species, such as the Syrian blackbird, spur-winged goose, knob-winged dove, jacana, mound-bird, and a few others; and in these cases it occurred either on the index or middle finger, or on the radial side of the metacarpus. All these facts lent additional proofs of the reptilian affinities of birds.

American Pedigree of the Camel.—Though the evolutional pedigree of the horse may be distinctly traced in the succession of equine genera whose remains are found in the Tertiary strata of our Western Territories, nevertheless, the horse, as he at present exists, is not indigenous to this continent, but has been imported from Europe. The pedigree of the camel may also be constructed from materials supplied by American paleontology. Prof. Cope has recently unearthed a number of genera which must be regarded as the ancestors of the camel. And it is worthy of note that, although the more prominent genera of the series which resulted in the horse, for instance *Anchitherium* and *Hippotherium*, have been found in European formations, no well-determined form of the ancestral series of the camel has up to the present time been found in any formation of the Palæarctic region. "Until such are discovered," says Prof. Cope, "there will be much ground for supposing that the camels of the Old World were derived from American ancestors."

Arctic Meteorology.—During Weyprecht and Payer's expedition to the north-polar regions the air in winter seemed always to contain particles of ice. This was seen not only by parhelia and paraselenæ when the sky was clear, but also in astronomical observations. The images of celestial objects were hardly ever as clear and well defined as at lower latitudes, although the actual moisture in the atmosphere was far less than is usual in temperate climes. It happened very often that, with a perfectly clear sky, needles of ice were deposited in great quantities upon all objects. It was impossible to determine the quantity of atmospheric deposits, as during the snow-storms no distinction could be made between the

snow actually falling and that raised from the ground by the storm. It was remarkable, however, that during the first winter the quantity of snow was small compared with that of the second winter, when the snow almost completely buried the ship. The same proportion was repeated in the quantity of rain during the first and second summer; in the first only a little rain fell and that late in the year, while in July, 1874, it rained in torrents for days.

Life in Elevated Areas. — The general belief in the invigorating effect of mountain-air is not absolutely justified by facts: at least there are some elevated regions the inhabitants of which show none of the vigor and *élan* which we should expect to find, were the common opinion correct. Dr. Jourdanet, of Paris, writes of the inhabitants of the table-land of Anahuac, Mexico, that they appear quite languid, with pale complexion, ill-developed muscles, and feeble circulation. The mortality of infants is 30 per cent. in the first year after birth. Dr. Jourdanet is satisfied that, while the proportion of red corpuscles in the blood is normal, there is a diminution of oxygen, the result of insufficient condensation of that gas under the slight pressure of the air. For this condition of the blood he proposes the name of *anoxyhæmia*. In Mexico, at the height of about 2,300 metres (7,500 feet) above the sea, the debilitating effects of the rarefied air are manifest. This is noticeable in brutes as well as in men. Again, the annual growth of population is scarcely ever more than three per 1,000 on the uplands, while nearer the sea-level it is six or seven. Dr. Jourdanet asserts his belief that, in countries where cold is not of itself an obstacle to life, rarefaction of the air will prevent the founding of durable states at a level higher than 4,000 metres.

Chinese Wheelbarrows.—In commenting on an improved style of wheelbarrow, a correspondent of the *Gardener's Chronicle* praises the Chinese for the ingenuity they display in diminishing to the last degree the labor of the man who propels the barrow. The Chinese barrow has but one wheel, but it is large, and placed in the centre of the bed of the vehicle; the entire load rests on this central wheel. In Shanghai, thousands of these vehicles ply for hire in the streets, the usual load being two persons, who sit on a wooden platform on each side of the wheel, resting one arm on a framework which rises above the top of the wheel, and planting one foot in a stirrup made of rope. "It is by no means uncommon, however," he adds, "to see as many as four persons conveyed without any particular effort (the ground being level) by a stalwart coolie;" garden and farm produce is transported in the same way, and even live-stock: the Chinese farmer being too sensible to attempt to drive his pigs to market, the barrow is often seen laden with a live fat hog on each side of the wheel.

Cave-Habitations in Kentucky. — That some of the great caves of Kentucky were, temporarily at least, used as places of human habitation, is conclusively shown by Prof. Putnam's exploration of Salt Cave. This cave, says Prof. Putnam, approaches the Mammoth Cave in the size of its avenues and chambers. Throughout one of the principal avenues, for several miles, were to be traced the ancient fireplaces both for hearths and lights. Bundles of fagots were found in several places in the cave. But the most important discovery was made in a small chamber, about three miles from the entrance. On the dry soil of the floor were to be seen the imprints of the sandaled feet of the former race who had inhabited the cave, while a large number of cast-off sandals were found, neatly made of finely-braided and twisted rushes.

The Use of Bushy Tails.—It is easy to see the usefulness to the opossum, monkey, and other animals, of their prehensile tails. So, too, we can recognize the value to the horse and the ox of the switches by means of which these animals repel the attacks of insects. But there are other forms of the tail the uses of which are less evident, for instance, the bushy tail seen in the fox, dog, wolf, cat, etc. Mr. Lawson Tait holds that the use of this bushy appendage is completely analogous to that of the respirator worn by persons troubled with lung-complaints, the object being to abstract from the expired air, by means of fur in the one

case, and wire gauze in the other, the heat which is being taken out with it; so that the cold air inspired shall be raised in temperature before it reaches the lungs, and thereby conduce to a conservation of the bodily heat. Some interesting considerations bear on this. Animals provided with bushy tails seem to be so as a matter of correlation of growth, their bodies being always provided with thickly-set and more or less soft fur. "I cannot," says Mr. Tait, "find an animal with a bushy tail which cannot, and does not, lie curled up when asleep. I went round the Zoölogical Gardens at Dublin on a very cold morning in February, and found the civet cat, and some other bushy-tailed animals, coiled up with their noses buried in the fur of their tails.

"In the squirrel this use of the tail is very marked, and in birds the same object is accomplished by their burying their heads in the down of the shoulders. Animals provided with bushy tails are all solitary in their method of living, so far as I can find; and, therefore, an essential for their survival is some method by which variations of temperature shall be resisted. The use of the tail for this purpose is, I think, best of all illustrated in the great ant-eater (*Myrmecophaga jubata*), in which the hairs of the tail reach a very great size, and cover up the animal when reposing, so that he looks like a bundle of dried grass. It may also serve as a protection by mimicry in this case. Mr. Wallace states also that this animal uses its tail as an umbrella in a shower, and that the Indians divert its attention from themselves by rustling the leaves in imitation of a falling shower, and while he is putting up his umbrella they kill him. Of the quadrumana, the marmosets afford a striking instance of a bushy tail as a probable provision for protecting these delicate creatures from depressions of the temperature."

Remedy for Boiler Incrustations.—"Apparatine" is the name given to a substance said to be effectual in preventing incrustation in boilers, and also useful wherever gelatine and gelatine-like substances are required, as in sizing textile fabrics. It is a colorless, transparent material, obtained by treating any amylaceous substance with a caustic alkali. It is best made, however, with potato-starch, treated with a lye of caustic potash or soda. The best method of preparing the apparatine is as follows: 16 parts of potato-starch are put into 76 parts of water, and kept in a state of suspension by stirring; then 8 parts of potash or soda-lye at 25° Baumé are added, and the whole thoroughly mixed. In a few seconds the mixture suddenly clears, forming a thick jelly, which must be beaten up vigorously. It is now a colorless, transparent substance, slightly alkaline in taste, but odorless, and of a stringy, glue-like consistency. Exposed to the air, it dries slowly, but without decomposing; and even when heated to dryness, although it thickens and swells, it continues unchanged, as when air-dried.

To prevent incrustation, the apparatine may be placed in the boiler or added to the feed-water in the tank; but the best results have been obtained by placing it directly in the boiler. Applied to silk, woolen, and cotton goods, it gives them a smoothness hitherto unattainable. When once applied to the goods, and become dry, it appears to be virtually insoluble. Diaphanous or coarsely-woven fabrics, when dressed with apparatine, are rendered stiff and rigid. It may be used as a thickening in calico-printing.

NOTES.

A CORRESPONDENT of the *Scientific American* states that in Minneapolis a supply of water for extinguishing fires is obtained in localities beyond the reach of the city water-works by sinking four drive-wells at distances thirty feet apart, or fifteen feet from a centre. The pipes (2½ inches) of the four wells are brought together at the top, where the suction-hose of the fire-engine is attached. On trial an engine threw a continuous stream from a 1¼-inch nozzle for one hour. The water in the tubes was then at the same height as at the beginning.

THE chaparral-hen is described by a sportsman in Texas as a very pretty bird. The female lays one egg, and then commences sitting. While sitting she lays four more, the first being the largest and the fifth the smallest. The birds, when grown, seem to be of the same size. By the time the fifth egg is hatched the first is nearly a full-fledged bird. The first egg is about the size of a pheasant's; the others range in size between the pheasant's and the quail's egg.

A MASS of native copper, in weight 6,000 pounds, and taken from an ancient mine on Isle Royal, Lake Superior, is now on exhibition in St. Louis. The mass had evidently been detached from its bed by the ancient miners.

FROM calculations made by Dr. J. T. Luck, of St. Louis, it appears that the death-rate among officers of the United States Navy is astonishingly high, being last year 25.45 per thousand. Assuming the average age of naval officers to be thirty, the death-rate is three times as high as that of civilians.

THE growing appreciation of American scientific work in France is evidenced by the action of the Minister of Public Works authorizing an exchange of the *Annales des Mines* with sundry American journals and publications of scientific bodies.

To encourage local collectors and amateurs of science in the work of determining the ichthyology of Indiana, Prof. D. S. Jordan, of the State Geological Survey, has published a preliminary list of the fishes which he has himself found, and adds a list of those likely to occur in Indiana waters.

AT the initial meeting of the Khedival Society of Geography, held June 2d, the Khedive was represented by his second son, Hussein Pasha, and there were present most of the prominent representatives of the foreign colony in Cairo. The president, Dr. Schweinfurth, addressed the meeting in French. "Science," said he, "which had been carried from Egypt into Greece and Italy, and thence into Central Europe, was now returning to its birthplace. By the munificence of the Khedive, a society had now been established whose object it would be to advance the oldest, the most universal, and the most popular of the sciences. Unlike its sister associations in Europe and America, which have their field of research in distant lands, the Khedival Society had all its work to do at home, so to speak."

IN a lecture at Edinburgh on carnivorous plants, Dr. Balfour stated that young plants of *Dionæa muscipula* under bell-glasses do not thrive so well as those left free, and that while a piece of beef wrapped in another leaf becomes putrid, a piece inclosed by the *Dionæa* remains perfectly inodorous, but soon loses its red color, and is gradually disintegrated more and more till it is reduced to a pulp.

PALLADIUM, when coated with palladium-black, becomes saturated with hydrogen much more rapidly than the clean metal. If, when thus saturated, it be wrapped in gun-cotton, an explosion ensues after a few seconds, and the platinum plate burns for a short time with a feeble flame.

EXPERIMENTS made by Pfaff show ice to be by no means a bad conductor of heat. Taking the conductivity of gold as 1,000, platinum is 981, silver 973, iron 374, ice 314, and tin 303. Dr. Pfaff suggests that his results will modify our views of the physical condition of the interior of a mass of ice.

FROM the observations of Ebermeyer it appears that, in a given species of tree, the size of the leaves differs in proportion to the elevation. With equal strength of soil, the leaves decrease with height. Again, the entire amount of ash in the leaves decreases with the height; and the proportion of phosphoric acid in the ash is much less in high positions than on low ground.

STATUETTES and other artistic forms in plaster are made very closely to resemble silver in appearance by being covered with a thin coat of powdered mica. This powder is mixed with collodion and then applied to the objects in plaster with a brush, after the manner of paint. The mica can be easily tinted in various colors. It can be washed in water, and, unlike silver, is not liable to become tarnished by sulphuretted gases.

IN Great Britain and Ireland, the excise duties on liquors for the year ending March, 1875, amounted to £31,917,849, being an increase of £600,000 over the previous financial year.

"So popular are Mr. Darwin's books," says the *English Mechanic*, "and so widely read, that a countryman with a basket of round-leaved sundews (*Drosera rotundifolia*) has stationed himself near the Royal Exchange in London, and there daily drives a very good trade."

THE excellent Abbé Moigno, editor of *Les Mondes*, and general manager of the Catholic enterprise for diffusing a knowledge of science among the laboring-classes in France, has issued a work entitled "Explosions of Freethinking in August and September, 1874," containing the discourses of Tyndall, Du Bois-Reymond, R. Owen, Huxley, Hooker, and Sir John Lubbock. The abbé appends annotations of his own. This is as it should be: poison and antidote!

IT is asserted by E. Heckel, as the result of experiments made upon certain rodents and marsupials, that these animals, when fed on the leaves of poisonous solanaceous plants, are not subject to any injurious effects.

A COMMITTEE appointed for the purpose of investigating the working of the government telegraph system in England reports that the present rate, one shilling per message, is too low, and recommends that it be

increased fifty per cent. The *Examiner*, on the contrary, asserts that only by a *reduction* of fifty per cent. can the telegraph service be made self-sustaining. Such reduction, it is claimed, would have the same result as cheap postal rates.

From experiments made on a large number of animals belonging to different orders, Rudolph Pott concludes that, of all animals, birds exhale the greatest amount, proportionately, of carbonic acid; after birds rank the mammalia, and then insects. Worms, amphibia, fishes, and snails, exhale much less carbonic acid than birds, mammals, or insects. The influence of age on carbonic-acid excretion is very marked: thus, for example, an old mouse exhaled in a given time 3.873 grammes, a young one 4.349. But with insects the case is different, old individuals exhaling more carbonic acid than young.

In Turkey, Russia, and Peru, the number of pupils receiving primary instruction in schools forms from $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of the population; in Spain, 1 per cent.; in Italy, 6; in Hungary, $7\frac{1}{2}$; in Austria, 9; in England and in Norway, 12; in France, 13; in Prussia, 15; in the United States, 17.

On subjecting fishes to a pressure of ten atmospheres, Moreau found that the operation produced no injurious effects whatever. He then suddenly withdrew the pressure, and the fishes succumbed quickly from hæmorrhage, the blood having a frothy appearance. This phenomenon is due to the disengagement of the gases which, under the high pressure, had been taken up by the blood in great quantities.

It is stated in *Iron* that De la Bastie's glass loses its molecular cohesion under a repetition of blows, and then breaks like common glass. Tempered glass, submitted to hammering, presents an appearance on fracture similar to that of *fatigué* steel, a molecular disintegration having taken place. It is feared that this alteration of structure and loss of temper may not only follow from shock, but may happen spontaneously from interior change in the lapse of time.

A recent examination of the hull of the steamship Great Eastern showed a comparative absence of barnacles, though the stern-post, rudder, and screw were covered with them. The rest of that portion of the hull, which as a rule is below water, was clad with an enormous number of mussels, a surface of 52,000 feet being coated in parts to a depth of six inches. The total weight of the mussels is estimated at about 300 tons.

The income of the French Association last year was 37,126 francs, and its capital fund now amounts to 174,731 francs. The Association gained 500 new members at its last meeting. Though the strictest economy must needs have been practised to accumulate so considerable a fund as 175,000 francs, nevertheless the *material* encouragement of scientific investigators is not neglected. Last year 12,350 francs were distributed for purposes of research.

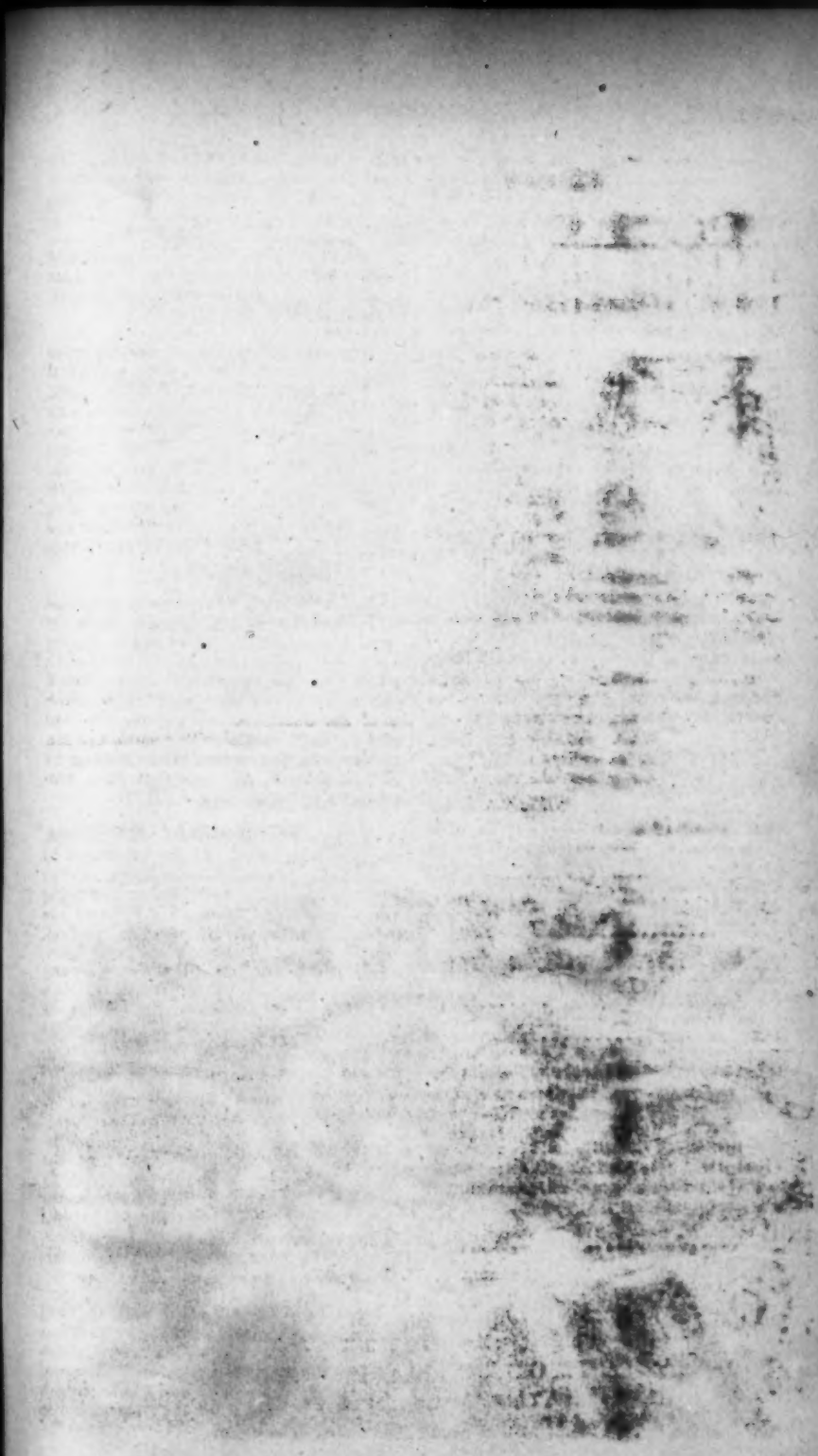
Hitherto batrachians of existing types have been regarded as of recent geological date—not earlier than the Tertiary epoch. Recently, however, batrachian remains were discovered in palæozoic rocks at Igornay (Saône-et-Loire), France. These remains have been described by A. Gaudry, who discovers in them affinities with the salamanders. Though the specimens appear to be adult, they are very small—a little over one inch in length. They occur in bituminous schists of the Permian age.

As a substitute for the dredge in removing sand-banks and other deposits from rivers, a French engineer proposes to employ metal pipes pierced with holes; these pipes are inserted into the mass of the sand-bank and water driven through them at considerable pressure. In this way the sand and mud would be raised and agitated, and carried away by the current of the river or by the ebb-tide, if the operation were conducted at the ebb.

According to Boillot, a French chemist, the bleaching effects usually attributed to chlorine are in reality due to ozone. Ozone employed directly acts as an oxidizing agent, laying hold of the hydrogen of the substance with which it is in contact, whence results bleaching if the body is colored. On allowing chlorine to act upon any animal or vegetable matter, it decomposes a certain quantity of water and seizes its hydrogen, forming hydrochloric acid. The oxygen set free by this reaction is transformed into ozone, which in its turn lays hold of hydrogen present in organic matter.

Actual experiment in England has demonstrated the great advantages of the hammock system of conveying invalids by railway. The invalid suffers neither jar nor jolt. It is proposed to extend the benefits of the hammock system to the general traveling public, thus reducing the discomfort of railway-travel to the minimum.

The cultivation of tea is making rapid progress in Ceylon, and extensive clearings of forest-land were made during the past year for forming new plantations. The seed is generally imported from India, though the Assam hybrid and China teas are also cultivated extensively.



PRINCIPAL J. W. DAWSON.